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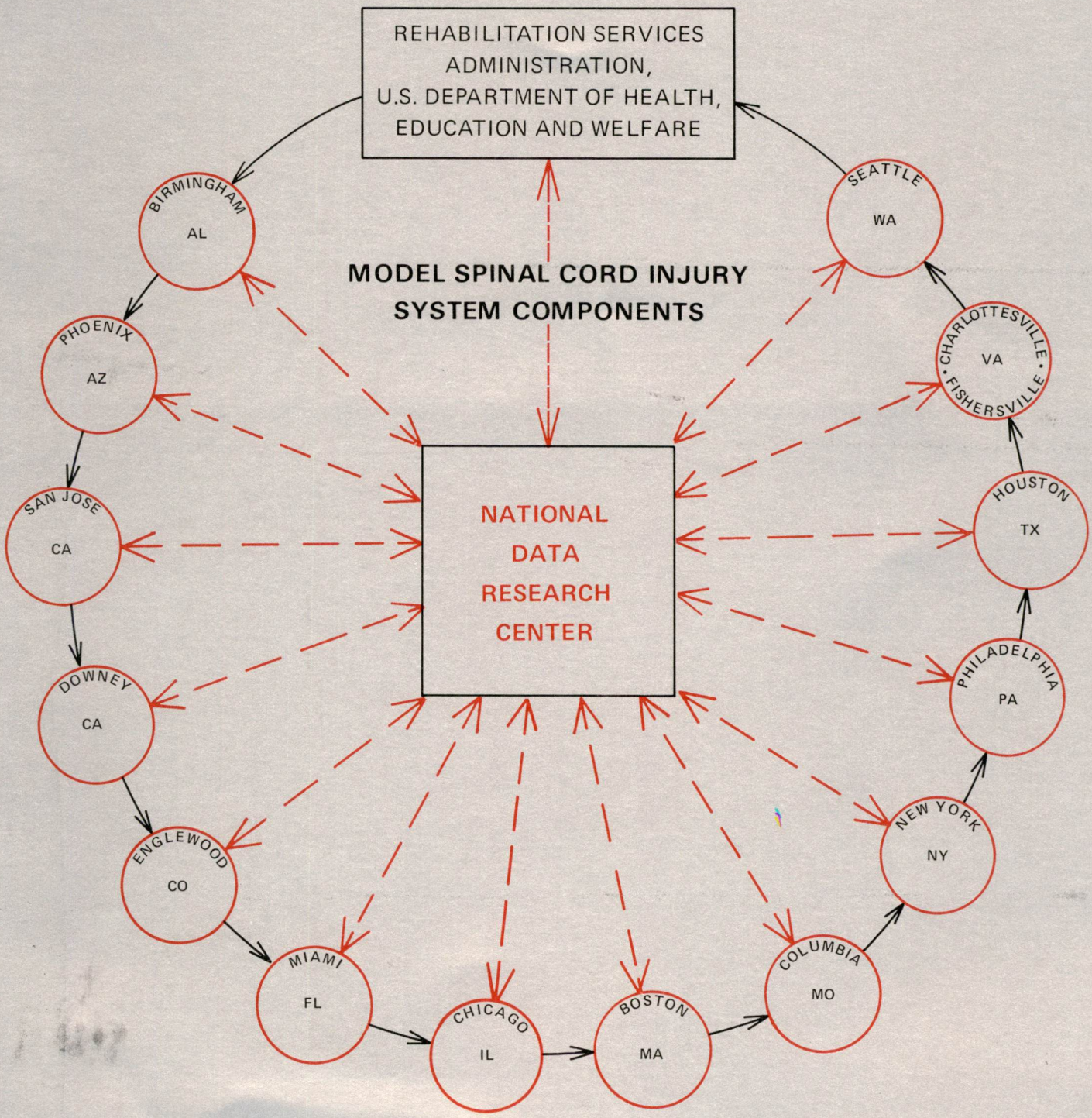
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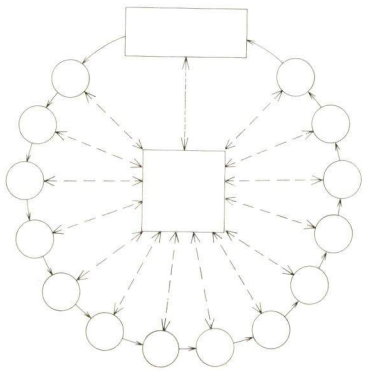
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MODEL SYSTEMS'

SCI DIGEST

Volume Two
Issue One
Spring 1980





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.*

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FROM THE DATA BANK . . .

ROOTS



John S. Young, MD

The newest kid on the block, Rancho Los Amigos, in affiliation with the Los Angeles County—University of Sourthern California Medical Center, became the fourteenth Regional Spinal Cord Injury System designated by the Rehabilitation Services Administration. In truth, "the kid" has been around for a long time.

During the first half of this century, the grim specter of poliomyelitis hovered over every community. Epidemics sprang up sporadically throughout the country each year without apparent rhyme or reason. Poliomyelitis is a terrifying disease. It is frequently fatal but more typically, it is a crippler—predominantly of children and young adults.

In the 1930s, polio patients were primarily treated in hospitals which maintained communicable disease units. Gradually, their acute care was shifted to general hospitals with a resultant drop in mortality and a rise in the number of severe cases that survived the acute illness to face a life of hopeless dependency. Many governmental and private medical and lay organizations were involved in finding a cure and minimizing the crippling effects of the disease. Foremost among these was the National Foundation for Infantile Paralysis, (The March of Dimes) a volunteer organization, which raised millions of dollars to fund clinical care, research and education.

One of the most serious problems the National Foundation had to face was that of providing good care for an increasing

(continued on page 48)

In Memoriam . . .

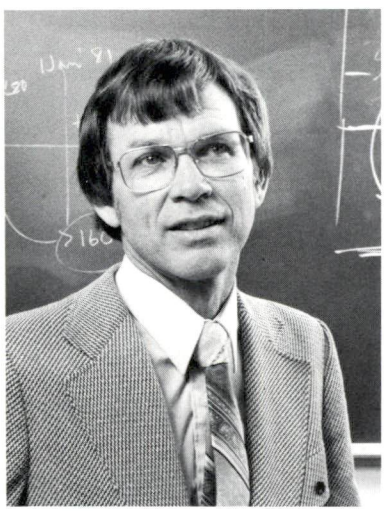
SIR LUDWIG GUTTMAN died March 18, 1980. A Memorial Service was held for him in the Stoke Mandeville Sports Stadium April 23rd. He was the founder of the National Spinal Injuries Centre in 1944 and the Stoke Mandeville Games in 1948 leading to today's International Olympiad for Paraplegics. Sir Ludwig received the honour of knighthood for a full life-time of outstanding work. The time has come to say good-bye to a good friend and a great leader.

REGIONAL SPINAL INJURY SYSTEM of SOUTHERN CALIFORNIA

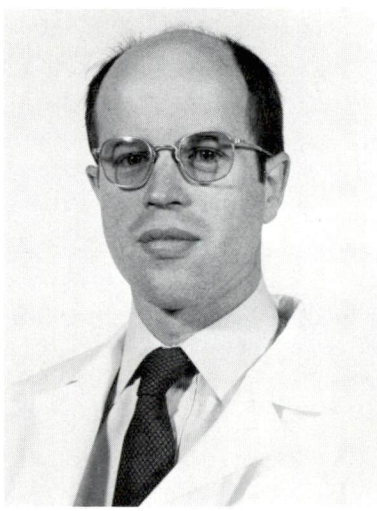
Robert L. Spears, MD
Robert L. Waters, MD
Martin L. Weiss, MD
Southern California Regional
Spinal Injury System
Downey, California

In October, 1979, Rancho Los Amigos Hospital in affiliation with the Los Angeles County-University of Southern California (LAC-USC) Medical Center became the fourteenth Regional Spinal Cord Injury (SCI) System in the United States designated by the Rehabilitation Services Administration, Department of Health, Education and Welfare. This designation formalized a long-standing co-operative effort between these two institutions. Both have long histories of providing health care for residents in the Southern California area.

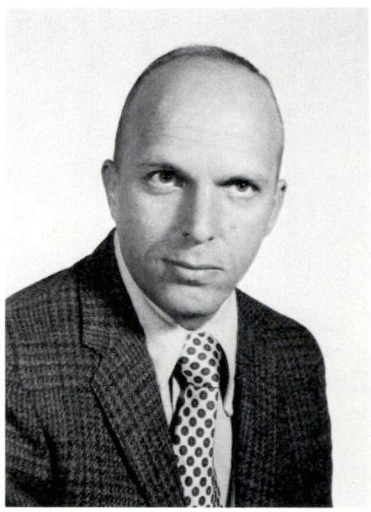
Robert L. Spears, MD, Project Director of the Southern California Regional Spinal Injury System (SCRSIS) is also, Medical Director of the Rancho Los Amigos Hospital in Downey, California. The SCRSIS Co-Project Directors are: Robert L. Waters, MD, Chief, Surgical Services, Rancho Los Amigos Hospital and Martin L. Weiss, MD, Chairman, Department of Neurosurgery, LAC-USC Medical Center in Los Angeles, Calfironia.



Robert L. Spears, MD



Robert L. Waters, MD



Martin L. Weiss, MD

HISTORICAL BACKGROUND

LAC-USC MEDICAL CENTER

The first county hospital in Los Angeles was established in 1858 by the Sisters of Charity in an adobe home belonging to Cristobal Aguilar. The hospital consisted of four rooms with a total of ten beds (cots) — two for the Sisters and eight for patients. There were two wards: one for paying patients and the other for county patients. At that time, the Sisters were reimbursed by the county at the rate of one-dollar per patient per day, later the rate was reduced to seventy-five cents. From May 4 thru November 2, 1858, Cristobal Aguilar was paid a total of $320 rent for the hospital. On November 13, 1858, the hospital was moved to a larger building.

In 1878, the first county-owned hospital was built. It included a large two-story main building and three outer buildings. The first story of the main building had four wards with twelve beds each. The second story had three wards, two single bedrooms for special cases and sleeping quarters for the overseer, nurses, and cooks. Two of the outer buildings were reserved for the treatment of patients with contagious diseases and the third was used as a dining room.

In January 1879, it was reported that the building of the "new" County Hospital accounted for a reduction in the average cost of care from $1.04 per patient day to $0.40. Nevertheless, the *Los Angeles Star* in their January 19, 1879 issue had the following comments concerning food and drug cost for the previous month:

> *"It appears that only $7.50 was expended for vegetables and $133.30 for meat. The bread bill was $53.72 and the grocery bill, deducting the amount on hand, $144. As many of the patients are invalids, it would seem that a little less meat and more vegetable food would be an improvement. The bread also if made entirely in the hospital, ought not to cost $1.75 per day. Neither should the groceries cost $5.00 per day for fifty patients. . . The medicines are put down at $69.46; from which it is evident they are dealt out by an old school physician or possibly by a druggist, who forgets that nature is the great curative agent, and that drugs are only so many poisons, the excessive use of which is not only expensive, but actually injurious."*

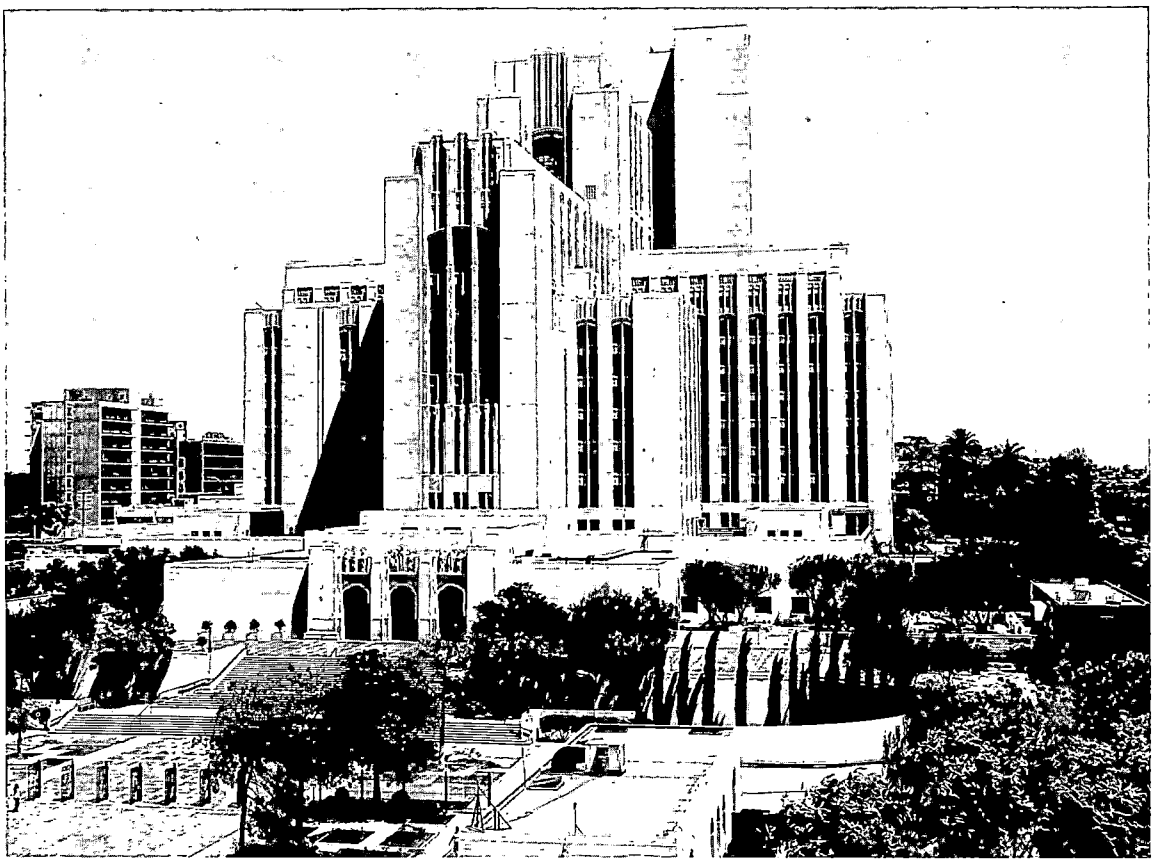
It is interesting to note that the diagnoses for 18 of the first 48 patients transferred to the "new" County Hospital from the Los Angeles Infirmary were paralysis.

In 1885, the College of Medicine of the University of Southern California was founded. By 1890, the first alliance between the University of Southern California and the Los Angeles County Hospital was formed. The faculty members served as attending physicians at the County Hospital and the medical students received their training there.

From 1878 to 1933, Los Angeles County grew extensively and so did the County Hospital. The number of beds increased from 106 to 1494. In 1890, there was one intern. By 1933 there were 98. Yearly admissions increased from 192 in 1878 to 38,144 in 1933. Between 1920 and 1924, yearly admissions climbed from 12,443 to 20,778. A bond issue for the building of the present Los Angeles County Hospital was passed in 1923.

On completion, the Los Angeles County General Hospital (LACGH) had 1,726 beds, 144 bassinets for the newborn, and a 3,600-bed expansion capability. Today, LACGH operates approximately 2,200 beds. At the formal dedication on April 15, 1934, the LACGH auditorium was decorated with flowers from Rancho Los Amigos Hospital and the programs for the dedication were printed at Rancho's Occupational Therapy shop.

In 1968, the name of the hospital was changed to the Los Angeles County-University of Southern California Medical Center.



LOS ANGELES COUNTY-UNIVERSITY OF SOUTHERN CALIFORNIA MEDICAL CENTER

RANCHO LOS AMIGOS HOSPITAL

Originally known as the Los Angeles County Farm, Rancho at first provided a home for the County's ill and indigent.

As early as 1885, the County had started buying parcels of land for its Farm. A total of 540 acres, north and south of what is now Imperial Highway, were acquired. These acres were a small part of a 1794 Spanish land grant — an area called California's Third Rancho. Of the initial four buildings on the County's property, two were used as wards that housed some 60 ambulatory patients.

To make the Farm as nearly self-supporting as possible, crops were planted, a Dairy Farm was added, and chickens and porkers were raised. Records show that during 1913-14 the net cost of operation was 83.8 cents per resident per day. The more able male patients worked in the fields and dairies.

In the early 1900's, the Farm was gaining attention for its herd of Holsteins, who were setting world records for milk and butterfat production. William R. Harriman, superintendent of the Farm from 1915 to 1952, was quoted in a New York publication as saying ". . . For the calendar year of 1919 the average number of cows milked was 96.22. . . The herd produced, during the year, 1,361,003 pounds of milk and 48,553.8 pounds of fat. . ." Prize bulls enhanced the herd's reputation and growth. Rancho's historical archives carry photographs and achievement records of these magnificent animals. Belgian draft horses, many with faultless pedigrees, served as additional farm power and purebred Hampshire sheep were purchased to clear up weeds and waste fodder.

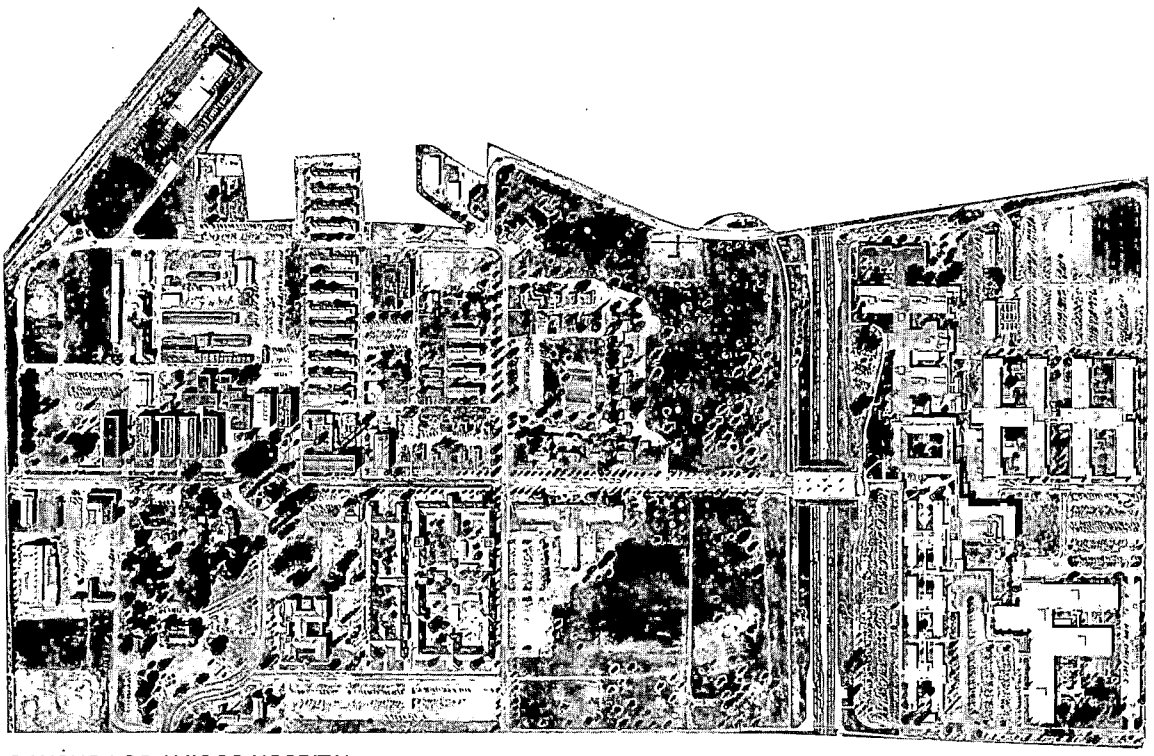
While the emphasis seemed to be on animal breeding and breaking world production records, the character of the Farm was slowly changing. In the early 1900's, patients with chronic medical disorders, requiring physician and nursing care, were admitted and appropriate personnel were hired to care for them. The increase in patients corresponded with the growth of Los Angeles. In 1924, the Farm's livestock herds had to be destroyed because of an epidemic of hoof and mouth disease. By 1929, the hospital's annual census was 1,967 patients with various chronic disorders. An analysis of a portion of the patient population that year showed 330 paralyzed persons, 242 otherwise crippled, 49 blind, 119 partially blind, 76 deaf, 40 epileptic and 81 feeble-minded. There was a wide variance in age, nationalities, trades, education and general backgrounds.

While such things as new feeding sheds and irrigation pipes were still showing up on the books, facilities for patients and staff were also being added. The new Women's Ward Building, completed in 1929 to house 200 patients, had all outside rooms with steam heat as well as hot and cold running water. Parlors on each floor were wired for radio connections.

Purchases included the most up-to-date equipment available. By now, Rancho maintained its own pharmacy, laboratory, dental unit, physiotherapy room, X-ray department and occupational therapy shop. The nursing staff had been increased to maintain a ratio of approximately one employee to each four patients, with a graduate nurse in charge at all times. Rancho was acknowledged as the largest county-owned institution in Los Angeles — "and probably in the world."

In accounts of this period, the current philosophy of Rancho began to emerge. An article published in 1929 (source unknown) about the Occupational Therapy Facility included this statement: "By providing a constructive outlet for their activity and thoughts, this department has worked a wonderful improvement in the physical and mental condition of many handicapped patients; stiffened joints, wasted muscles, and troubled minds improving day by day as the worker realized that he is still a producing unit of society with definite value to himself and others."

In 1932, the Los Angeles County Board of Supervisors officially named the Farm/Hospital, Rancho Los Amigos Hospital (RLAH).



RANCHO LOS AMIGOS HOSPITAL

Rehabilitation developed as Rancho's major activity during the epidemic of poliomyelitis that occurred in 1944. Rancho Los Amigos Hospital became a regional center for post-polio patients at that time.

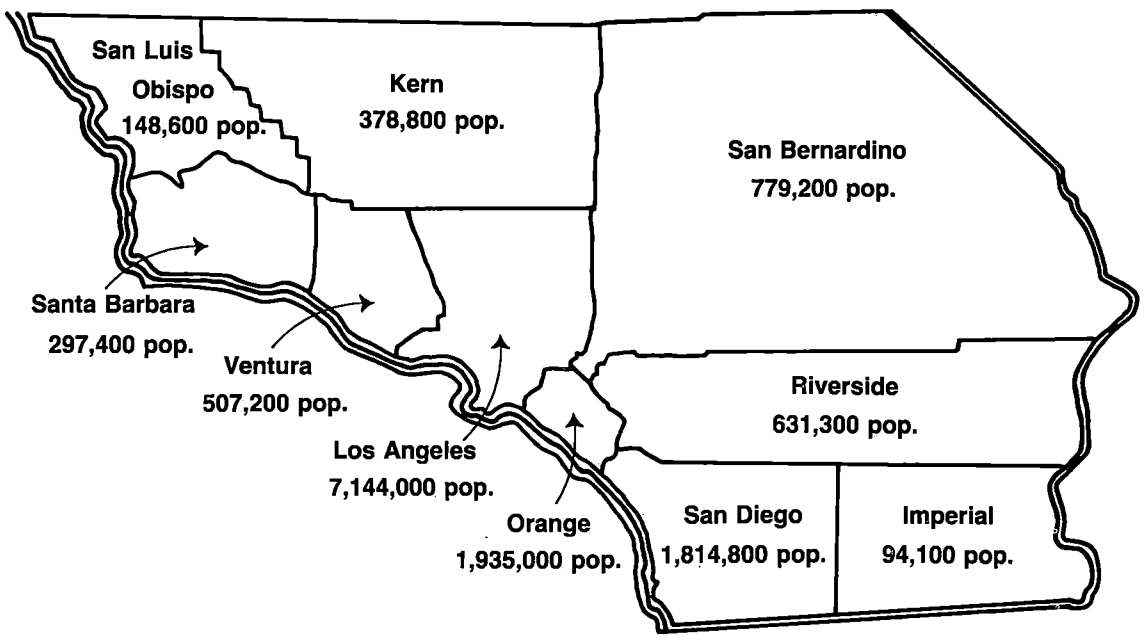
With funds, facilities and staff provided by the County of Los Angeles and the National Foundation of Infantile Paralysis, Rancho Los Amigos Hospital demonstrated that the condition of patients with severe physical impairment could often be substantially improved by intensive therapy, reconstructive surgery and medical management, so that many were able to return to the community and to lead productive lives.

Today, Rancho Los Amigos Hospital is an 849-bed Rehabilitation Center located on a 210-acre site. The Center offers services which include Spinal Cord Injury, Head Trauma, Stroke, Pulmonary, Cardiac, Reconstructive, Burn and Pain Rehabilitation. A separate Children's Building offers these services to pediatric patients under the care of full-time pediatricians. Specialized programs in Liver Disease treatment and research, Drug Abuse, and Tuberculosis are also available.

CATCHMENT AREA

Although Rancho Los Amigos and LAC-USC Hospitals serve people from all over the world, most of the patients reside in the ten southernmost counties of California with the largest number coming from the Los Angeles County. The combined population of the ten counties is approximately 13,730,400 with Los Angeles County accounting for close to half the populous (see Figure 1).

Figure 1. SOUTHERN CALIFORNIA REGIONAL SPINAL INJURY SYSTEM CATCHMENT AREA



The County of Los Angeles, which covers over 4,000 square miles, is predominantly urban in the central and southern areas with a population density of up to 12,000 persons per square mile. However, the County also includes over 1000 square miles of desert with a much lower population density. In addition, the geography of the County includes mountain ranges and shoreline. Because of the geographical variety within the County, it is topographically representative of the region.

SYSTEM COMPONENTS

EMERGENCY MEDICAL SERVICES

Emergency Medical Services (EMS) in Los Angeles and in the Southern California area are comparable to the most sophisticated systems in the United States. Los Angeles County was the first county in the United States to establish and implement an ordinance regulating EMT-I and EMT-II (Paramedic) training. Such pioneering efforts have provided considerable guidance to other EMS Systems throughout the country. Similarly, the San Diego County EMS System was one of five federally funded demonstration projects in the early 1970's, becoming a forerunner in establishing a highly developed EMS System. Orange County's EMS System is also now considered to be a model program for the country. The recent designation of Trauma Centers within Orange County — modeled after the State of Illinois — was a giant step toward improving the care of traumatized patients. Emergency Medical Services in San Bernardino and Riverside Counties are similarly being integrated by the Inland Counties Emergency Medical Authority.

Federal funding in recent years has allowed the development of an integrated system of Emergency Medical Services within the Los Angeles County Department of Health Services. By law, the Director of Health Services must certify paramedics before they may practice. This obligation is carried out through the Paramedic Training Institute located at the Los Angeles County Harbor-UCLA Medical Center. This training exceeds the minimum set forth under federal guidelines. Control of this function gives the County Health System the opportunity to include updated information on identification and care of spinal cord injured patients in the paramedic's training. On certification, these paramedics, whether employed by county or city fire departments or by private ambulance companies, are competent in the emergency extrication, treatment and evacuation of spinal cord injured patients. Approximately 147 paramedic-equipped vehicles are operated by 35 public and private agencies in the county.

Medical Alert Center (MAC)

A key element in the County's Emergency Medical System is the Medical Alert Center (MAC), located adjacent to the Emergency Room at the Los Angeles County-USC Medical Center. This County-operated unit functions in conjunction with the Hospital Council of Southern California and monitors speciality care beds in both public and private hospitals throughout the county and neighboring counties. Whenever a special care bed is needed, the dispatcher contacts the MAC for referral to the nearest available bed. The MAC also coordinates all emergency air transportation, medical resources for all mass casualties (freeway pile-ups, airport disasters, large fires, toxic substances) including sending triage teams, and dispatch of additional mobile intensive care units and ambulances to the scene of the disaster. First notification of an impending SCI transfer to LAC-USC Medical Center is received by the Medical Alert Center.

ACUTE CARE

LAC-USC Medical Center is the major County medical facility with approximately 2,000 beds for primary, secondary and tertiary trauma and other medical care. The Medical Center also serves all of Southern California as its specialized services are needed.

The Emergency Department is considered to be one of the busiest in the United States, with over 175,000 visits a year. All disciplines are immediately available 24 hours a day. All ancillary services, including radiology, tomography and angiography facilities and myelogram equipment are always available. On arrival of a spinal cord injured patient, the emergency medical staff calls for neurosurgical consultation personnel who institute a standard protocol for these patients.

(continued on page 41)

PERSONALITY CHARACTERISTICS OF SPINAL CORD INJURY PATIENTS AT INJURY AND ONE-YEAR FOLLOW-UP

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Charlottesville, Virginia
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Southwest Regional System for
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INTRODUCTION

Currently, six research projects concerned with psychological, social and vocational (PSV) adjustment factors in spinal cord injury (SCI) are funded by the National Institute for Handicapped Research (NIHR), U.S. Department of Health, Education and Welfare. These PSV Projects are located in Arizona, Northern California, Illinois, Minnesota, New York, and Virginia. With the exception of Minnesota, all PSV Projects operate within HEW funded Regional SCI Systems to investigate PSV adjustment relative to rehabilitation outcome and, thus, extend the effectiveness of the Regional SCI Systems. The primary focus of the PSV research is to determine what factors are related to maintenance of health, fulfillment of social roles, plus educational and vocational productivity.

This collaborative research is being conducted in both cross-sectional and longitudinal phases. For the longitudinal phase, all six PSV Projects have collected data for newly spinal cord injured patients as prescribed by a common research design. The Project is now in the third year of data collection. The data presented herein were provided by the four Projects located in Arizona, California, New York, and Virginia.

MINNESOTA MULTIPHASIC PERSONALITY INVENTORY

The Minnesota Multiphasic Personality Inventory (MMPI)—perhaps, the most widely used personality questionnaire—is designed to provide an objective assessment of qualitative as well as quantitative differences in personality and behavior. This instrument has been used in several previous studies to investigate personality traits and adjustment factors as related to spinal injury.

In one such study, Fordyce[1] examined the relationship between traits of personality and the manner of onset of disability. He found that patients who were rated as being less prudent with respect to the circumstances leading to injury showed themselves as more impulsive as reflected in MMPI scale scores.

Bourestom and Howard[2] used the MMPI in a study of personality characteristics of three disability groups: multiple sclerosis, rheumatoid arthritis, and spinal cord injury. In this study, the group of SCI patients was found to have similar MMPI profiles as compared to other disability groups but showed fewer neurotic symptoms as reflected on the MMPI scales.

The present study extends previous research on personality characteristics of spinal cord injured patients in that:

- The patient sample is more geographically representative of national SCI population.
- Test data were collected at precisely defined time intervals following the onset-of-injury.
- A uniform testing protocol was followed for all patients.
- Test data were examined according to sex and category of neurological impairment.

METHODOLOGY

Each patient included in this study met the following criteria: the patient was included in the study population for which ongoing data were being collected by the SCI Systems; a permanent impairment of neurological function existed as a result of a traumatic spinal cord injury; and the patient was between 16 and 60 years of age. All patients participated in this project voluntarily.

The MMPI was administered as a part of a larger test battery that included several standardized psychometric test instruments as well as a structured questionnaire used in the collaborative PSV research. The PSV test battery was initially administered during the time the patients were involved in intensive rehabilitation—4 to 12 weeks post-injury (T1).

The total study population consisted of 176 patients for whom MMPI data were available from the initial testing session. Included in this sample were 146 males, representing 70 paraplegics and 76 quadriplegics, and 30 females, representing 23 paraplegics and 7 quadriplegics. The mean age of this initial study sample was 28 years.

At this time, test data for 113 patients, who were included in the initial sample, have been obtained for the first annual follow-up. Typically, the follow-up testing occurred during a home visit or during the patient's visit to the hospital for an annual medical evaluation. Follow-up data collection occurred within two months from the first anniversary of the date of injury for each patient. Test data from both the initial, 4–12 week post-injury (T1), and the first year follow-up (T2) were available for 94 male patients, representing 40 paraplegics and 54 quadriplegics, and 19 female patients, representing 14 paraplegics and five quadriplegics.

RESULTS

All MMPI scale scores were computed using K-corrections in the usual manner and all protocols were judged to be valid. Group means and standard deviations were computed using T-Scores. Means, standard deviations, and differences between means of MMPI T-Scores for 70 male paraplegics and 76 male quadriplegics, who were tested at 4–12 weeks post-injury (T1), are presented in Table 1.

The MMPI profiles for male paraplegics and quadriplegics, presented graphically in Figure 1, are generally similar in that elevations are shown on the same scales for each patient group. For the male paraplegics, seven of the 10 clinical scales are elevated above a T value of 60, although none of these scales is over 70. The absolute scale elevations suggest that, as a group, these patients are characterized by a moderate degree of distress, a focus on somatic complaints and bodily health and functioning, and a moderate degree of impulsiveness.

Table 1. EVALUATION OF MMPI SCALE SCORES FOR MALE PARAPLEGICS AND QUADRIPLEGICS TESTED AT 4–12 WEEKS POST-INJURY

	NEUROLOGICAL IMPAIRMENT				
	PARA (N = 70)		QUAD (N = 76)		MEAN DIFFERENCE
MMPI SCALE	MEAN M_P	STD. DEV. SD	MEAN M_Q	STD. DEV. SD	($M_Q - M_P$) d
L	50.6	7.4	49.4	7.2	1.2
F	60.8	15.3	63.9	13.9	3.1
K	52.0	8.2	50.3	8.0	−1.7
Hs	66.2	11.5	72.4	12.8	6.2*
D	62.2	13.2	64.5	13.4	2.3
Hy	64.8	8.1	65.0	9.6	0.2
Pd	66.0	9.7	66.9	11.4	0.8
Mf	61.5	8.9	58.7	11.9	−2.8
Pa	58.9	11.1	61.9	13.1	3.1
Pt	59.6	12.2	63.2	12.4	3.6
Sc	67.8	14.2	74.7	17.2	6.9*
Ma	67.0	12.3	71.0	13.6	4.0
Si	50.9	8.9	51.4	9.5	0.5

*$p < .01$

The differences between means for paraplegics and quadriplegics for each scale is also shown in Table 1. The significance of differences between scale means for these two groups was evaluated using standard t-tests. Although the means for quadriplegics are higher on all but two scales, these are statistically significant for only the Hs (Hypochondriasis) and Sc (Schizophrenia) scales. The results suggest that, compared to paraplegics, male quadriplegics show more psychologic distress, physical symptoms and concern about physical health. As a group, quadriplegic males appear to express feelings of detachment, more unusual experiences and peculiarities of perception, and tend to show more signs of withdrawal.

Table 2 presents the means, standard deviations, and the differences between means for female paraplegics and quadriplegics tested at 4–12 weeks post-injury. Profiles of the MMPI scores for these two groups are shown in Figure 2. Again, the profiles for both categories of neurological impairment are generally similar. Some differences between these two groups are suggested by these data although no statistically significant differences were found when t-tests were used to compare the two groups. The profile for female patients is generally similar to that for males, although females appear to show less distress. Six scales for the paraplegic female group are just above the T value of 60, however, none exceed 65.

Differences between MMPI scale scores were compared for males and females with the results presented in Table 3. The means, standard deviations, and differences between means by sex category for paraplegic patients tested at 4–12 weeks post-injury are given in Table 3. As a group, male patients scored higher on all but the Pa (Paranoia), Pt (Psychasthenia), and Si (Social Introversion) scales. Males were significantly higher on the Hs (Hypochondriasis) and Mf (Masculinity/Femininity) scales, suggesting that male paraplegics, compared to females, may be distinguished as having greater concern about physical symptoms and, perhaps, physical health.

Table 2. EVALUATION OF MMPI SCALE SCORES FOR FEMALE PARAPLEGICS AND QUADRIPLEGICS TESTED AT 4–12 WEEKS POST-INJURY

	NEUROLOGICAL IMPAIRMENT				
	PARA (N = 23)		QUAD (N = 7)		MEAN DIFFERENCE
MMPI SCALE	MEAN M_P	STD. DEV. SD	MEAN M_Q	STD. DEV. SD	($M_Q - M_P$) d
L	50.5	6.9	50.9	3.4	0.4
F	58.5	13.7	59.7	12.0	1.2
K	51.8	9.0	47.6	8.0	−4.2
Hs	60.9	9.3	60.6	8.7	−0.3
D	58.0	10.5	58.9	15.8	0.9
Hy	61.6	8.9	59.9	8.1	−1.7
Pd	60.7	13.8	58.6	13.0	−2.1
Mf	54.1	12.1	45.7	8.8	−8.4
Pa	61.8	10.9	61.6	8.5	−0.2
Pt	60.3	9.8	61.3	12.5	1.0
Sc	62.8	10.7	67.1	18.7	4.3
Ma	62.3	10.0	63.4	14.9	1.1
Si	52.0	9.2	57.7	12.9	5.7

Figure 1. MMPI PROFILES FOR MALE PARAPLEGICS AND QUADRIPLEGICS TESTED AT 4–12 WEEKS POST-INJURY

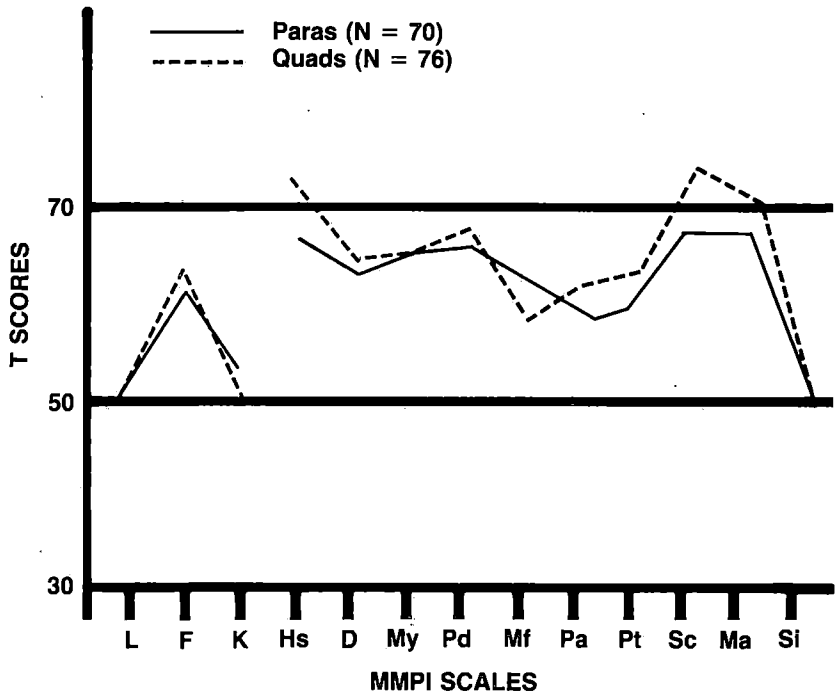


Figure 2. MMPI PROFILES FOR FEMALE PARAPLEGICS AND QUADRIPLEGICS TESTED AT 4–12 WEEKS POST-INJURY

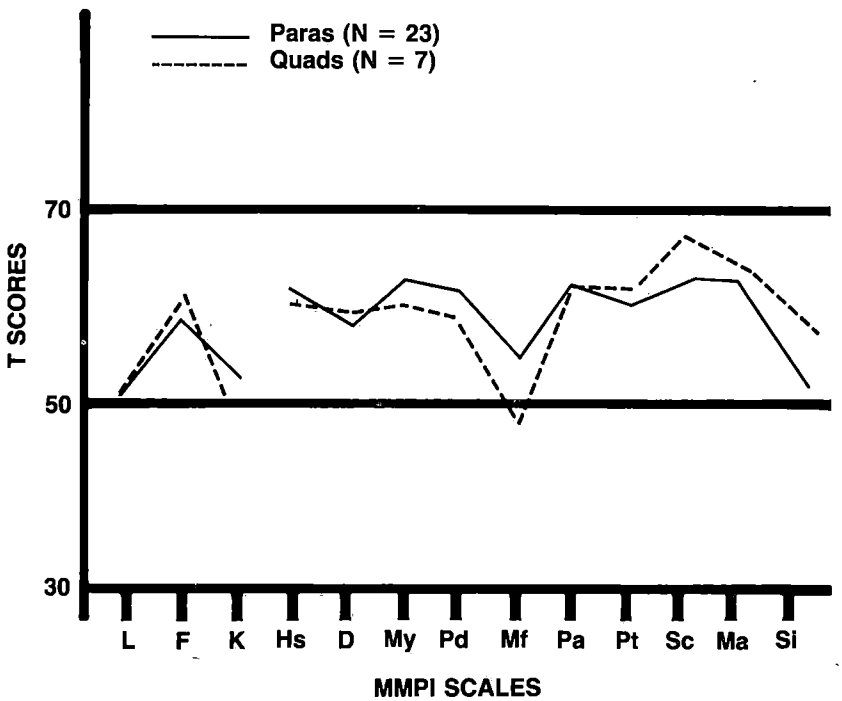


Table 3. EVALUATION OF MMPI SCALE SCORES FOR MALE AND FEMALE PARAPLEGICS TESTED AT 4–12 WEEKS POST-INJURY

	MALES (N = 70)		FEMALES (N = 23)		MEAN DIFFERENCE
MMPI SCALE	MEAN M_M	STD. DEV. SD	MEAN M_F	STD. DEV. SD	($M_M - M_F$) d
L	50.6	7.4	50.5	6.9	0.1
F	60.8	15.3	58.5	13.7	2.3
K	52.0	8.2	51.8	9.0	0.2
Hs	66.2	11.5	60.9	9.3	5.3*
D	62.2	13.2	58.0	10.5	4.2
Hy	64.8	8.1	61.6	8.9	3.2
Pd	66.0	9.7	60.7	13.8	5.3
Mf	61.5	8.9	54.1	12.1	7.4**
Pa	58.9	11.1	61.8	10.9	−2.9
Pt	59.6	12.8	60.3	9.8	−0.7
Sc	67.8	14.2	62.8	10.7	5.0
Ma	67.0	12.3	62.3	10.0	4.7
Si	50.9	8.9	52.0	9.2	−1.1

*p<.10
**p<.01

From the one-year follow-up (T2) data collection, MMPI profiles were available for a total of 113 patients, representing 94 males and 19 females. Within the male sample, T1 and T2 data were available for 40 paraplegics and 54 quadriplegics. For the female sample, both T1 and T2 data were available from 14 paraplegics and five quadriplegics. The T2 MMPI data were compared to the T1 data available for the same patients. For a succinct presentation of these differences, Table 4 is presented to show the differences between the means for each MMPI scale by sex and neurological impairment categories. The significance of these mean differences were assessed using the t-test formula for matched pairs.

The only reliable change which occurred on MMPI scales was for male paraplegics on the Ma (Hypomania) scale that was just reached at the .05 probability level. The Ma scale score for this group was higher at T2. This may suggest that at one-year post-injury, male paraplegics are perhaps more active in their thinking and behavior. Apart from this finding, the comparisons between T1 and T2 indicate essentially no changes between the onset-of-injury and one-year post-injury.

DISCUSSION

The results reported herein represent a much larger sample, with better geographic representation, than in previous studies of MMPI findings for SCI patients. Also, in contrast to previous studies, the impact of the present findings is greater because data were collected following a uniform test protocol administered at precisely defined intervals from the onset-of-spinal cord injury.

A major finding in the present study was the degree and pattern of elevation shown on several MMPI scales, which is not dissimilar to those reported previously.[1,2] The interpretation of these scale elevations is fairly complex; the scales are not a simple reflection of the extent of the SCI patient's psychopathology. In this regard, previous research conducted by Taylor[3] showed that the somatic relevance of some of the MMPI questions have

Table 4. EVALUATION OF DIFFERENCES BETWEEN MMPI SCALE MEANS FOR MALE AND FEMALE PATIENTS TESTED AT 4–12 WEEKS (TI) AND ONE YEAR (T2) POST-INJURY

	MALES		FEMALES	
MMPI SCALE	PARAS (N=40) $M_{T2}-M_{T1}$	QUADS (N=54) $M_{T2}-M_{T1}$	PARAS (N=14) $M_{T2}-M_{T1}$	QUADS (N=5) $M_{T2}-M_{T1}$
L	−1.3	−0.4	−0.1	−3.6
F	1.1	2.4	−0.6	1.4
K	−0.1	−1.1	−0.7	−2.6
Hs	−1.7	−2.8	3.4	2.6
D	−3.0	1.4	3.4	4.8
Hy	−2.3	−1.3	2.5	2.4
Pd	1.7	−2.4	5.3	6.2
Mf	0.8	0.3	−3.1	1.2
Pa	0.4	2.1	3.8	1.0
Pt	1.0	−0.7	2.0	−2.8
Sc	3.3	1.4	4.7	8.2
Ma	4.0*	0.5	3.2	3.8
Si	0.2	−1.1	2.2	3.2

*p<.05

a direct bearing on the extent of elevation obtained on several scales. Also, for individuals with a sudden and traumatically induced paralysis, increased attention relative to somatic symptoms and complaints plus increased concern about physical health, in general, may be both expected and appropriate. In this regard, a note of caution is appropriate. If MMPI data are interpreted by a rehabilitation professional, who fails to take into account the effect on these measures of the unique circumstances associated with spinal paralysis, the patient will appear much more distressed and show much more psychopathology than is actually the case. Using the MMPI as a part of a psychological evaluation of a SCI patient without consideration of these variables, is to render a disservice to the patient and other staff members who may be in a position of needing an accurate appraisal of the patient's functioning to plan treatment programs.

A major finding of this study was that MMPI scale scores essentially did not change between the administration of the T1 and T2 tests. This has implications regarding the process and speed of adjustment to spinal injury and, possibly, characteristics of individuals who become spinal injured. To the extent that MMPI data reflect the psychological impact associated with the sudden onset of disability, substantial decreases in scale elevations as a function of elapsed time from injury might be predicted. A test of this hypothesis will be possible as additional follow-up data become available from the ongoing PSV Projects. Some preliminary findings from the cross-sectional research previously conducted by these PSV Projects, suggest that significant changes in psychological symptoms occur over time—at least up to five-years post-injury.

With regard to when psychological impact may be shown or adjustment may occur—based on evidence gained from clinical observations—not atypically the patients' behavior during rehabilitation does not reflect the impact associated with an understanding of a diagnosis of permanent physical disability. It is quite common, in fact, for patients themselves to indicate that they did not fully appreciate the implications of their injury until they had opportunities to gain extensive experiences in their home environments after discharge from the initial hospitalization.

Another finding concerns the differences between male and female MMPI results. There is a trend for males to show somewhat more psychological distress. This is consistent with a previous report by Bourestom and Howard[2] that sex is a relevant variable in determining personality characteristics of individuals with spinal injury. In the present study, since there were relatively few females with both T1 and T2 MMPI data, it was not practical, from a statistical standpoint, to fully examine or attempt to explain differences between males and females. However, any differences between males and females can be meaningfully explored using the increased sample size that will become available through the PSV Projects' longitudinal data collection within the next few months.

CONCLUSION

A surprising finding of this study is that, as a group, SCI patients do not show a substantial degree of change in personality functioning at one-year post-injury compared to the 4–12 week post-injury time. This is in contrast to the popular belief that a significant degree of psychological adjustment occurs within the first year post-injury. Obviously, however, along with its various limitations, the MMPI is only one measure of personality functioning and, thus, is only one potential measure of adjustment to spinal injury. Whether or not psychological, social and vocational adjustment factors related to spinal injury are reflected more or less positively or accurately in other measures will await further research. Since a fairly large PSV longitudinal study is well underway, the answers to many of the questions, regarding the role PSV factors play in SCI rehabilitation, are expected as this research continues.

ACKNOWLEDGEMENTS

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INSTRUMENTATION FOR THE SEVERELY DISABLED: AN UPDATE

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CLINICAL EVALUATION OF ELECTRONIC ASSISTIVE DEVICES

During the early 1970's many new electronic assistive devices for the disabled were developed and marketed commercially. These devices enabled severely disabled individuals to achieve greater functional ability. Many of these devices appeared to be suitable for persons with high level spinal cord injuries.

Immediate incorporation of this instrumentation into the New York Regional Spinal Cord Injury System (NYRSCIS) Rehabilitation Program was impeded by inadequate clinical evaluation of these assistive devices and their suitability for the high level spinal cord injured. The high cost of most of the devices and their limited availability for "free" trial resulted in clinical testing which was incomplete and/or prohibitively expensive. To remedy this situation, the Institute of Rehabilitation Medicine (IRM) received funding for a formal clinical evaluation program of available electronic assistive devices in October 1974.

During the first three years, investigation was concentrated on devices which were operable by persons with spinal cord injury at or above the C-5 level. The scope of the project now includes the evaluation of devices for all types of severe disabilities.

POPULATION, PERSONNEL AND EQUIPMENT

To-date, 54 persons with high-level spinal cord injuries have participated in the evaluation of 34 different devices. The typical participant has been a young male of college age with a C-4 level of lesion but the ages range from 16-65 years and lesion levels from C-1 to C-5.

The evaluation team represents a multidisciplinary professional approach including a Physiatrist, Occupational Therapists, Biomedical, Electrical and Electronic Engineers, Psychologist, Rehabilitation Nurse, and both inpatient and outpatient "consumers."

Most of the devices evaluated were commercially available and were obtained through outright purchase. On-loan instruments, when available from manufacturers, were only accepted with "no strings attached". Prototype instruments, products of both in-house and/or extra-institutional development were also evaluated. Commercially marketed equipment was evaluated primarily because it is readily available on prescription and accessible to the disabled population.

DATA

During the first three years of the project, devices from the following categories were examined: environment, mobility (locomotion), typewriter control systems and electric page turners. Additional categories now being evaluated include recorder control systems, powered door operators, electric door locks, and new models of devices in previously investigated categories.

Devices were evaluated for electrical and mechanical performance, reliability, operational characteristics and user acceptance. In order to obtain comparative data, each participant evaluated all devices (whenever possible) of a single category (e.g., typewriters, etc.). Participants usually evaluated conventional methods of function (for example: mouthstick typing, etc.) as well.

EVALUATION SETTINGS

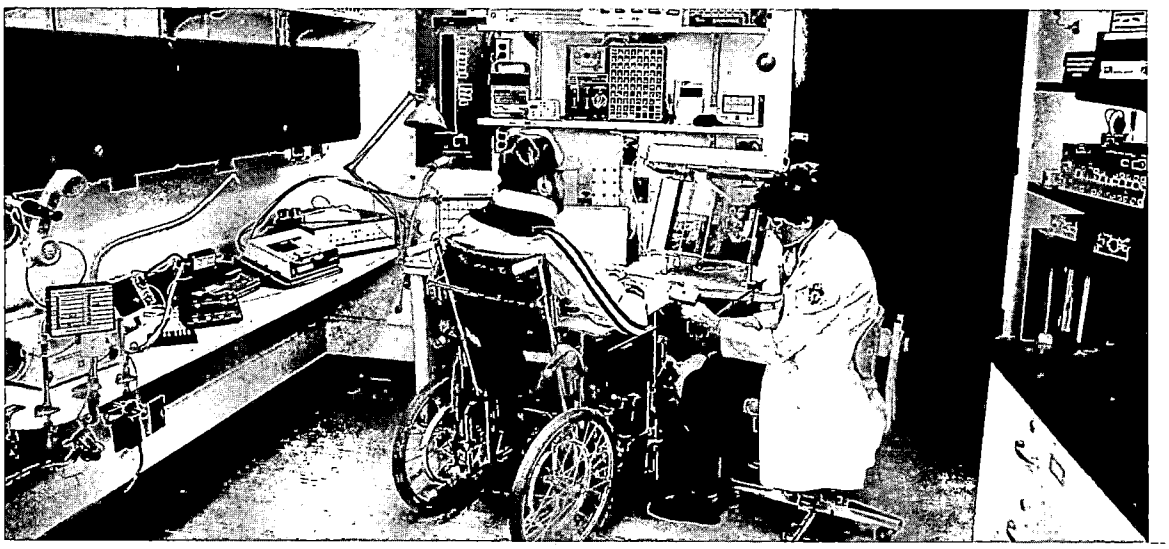
All devices were initially evaluated in the Occupational Therapy Electronics Laboratory shown in Figure 1. Long term findings on certain devices were then obtained through field trials. Environmental control systems were initially operated by participants round the clock at bedside on the nursing floors. Environmental control systems, which warranted home trials, were installed in a participant's residence (house, apartment, dormitory room, etc.). Locomotion control systems, which were assembled onto powered wheelchairs, were evaluated for general hospital use and progressed to post-discharge settings.

"Vocationally" oriented devices, such as typewriters and recorders, are evaluated in the pre-vocational treatment clinic and continued at home or on-the-job. Door locks and operators, which require installation for evaluation, are located within various in-hospital settings such as offices, laboratories, etc. These, too, will be followed for long-term findings as soon as home installation is feasible.

FINDINGS

The findings from a three-year investigation are given in a recently published monograph titled *Environmental Control Systems and Vocational Aids for Persons with High Level Quadriplegia.*[1] This publication is directed to individuals involved in the selection, provision and/or design of

Figure 1. OCCUPATIONAL THERAPY ELECTRONICS EVALUATION LABORATORY AT IRM



assistive equipment, especially Occupational Therapists, Vocational Counselors, Physiatrists, Engineers and, of course, the consumers. A summary of findings with respect to environmental and typewriter control systems was recently published in journal format.[2] Early findings on mobility control systems have been presented at professional meetings, and are available in reprints.[3,4]

A retrospective study revealed that when the activity patterns of users and non-users of an environmental control system were compared, the users were significantly more active, spent more time in educational activities, and were performing more independently than non-users. Individuals exposed to reliable electronic assistive devices during the early post-onset period of disability exhibited a greater probability of becoming users than did individuals not exposed during the early post-onset period. The findings of this retrospective study of the utilization impact of assistive devices on the daily lives of our target population have been completed and submitted for publication.[5]

A VOICE CONTROLLED POWERED WHEELCHAIR AND ENVIRONMENTAL CONTROL SYSTEM FOR THE SEVERELY DISABLED

CASE STUDY: CHRIS

Chris is a 20-year old former gymnast who broke his neck in an accidental tumble during athletic competition. On this particular morning as Chris opens his eyes, he can hear the muffled sounds of dishes rattling in the kitchen and the smell of sizzling bacon. He can hear his mother moving about in the kitchen as she prepares breakfast and his father showering in a nearby bathroom.

Chris turns his head toward a microphone positioned on a gooseneck attached to his headboard and says "ECU*, RUN, ROOM LIGHT, JOG*". The room lights go on and he commands "ECU, INTERCOM, JOG". He hears a click and says, "Mom, I'm awake. Is Dave (his attendant) here yet? JOG". The intercom switch closes and his mother replies from the kitchen "Good morning, Chris. Breakfast will be ready in about 15 minutes. Dave called to say he would be here by 7:30. Do you need anything till then?" Chris again switches the intercom on by saying "JOG" no thanks, Mom. I'll watch the news and get a weather report, JOG" (Intercom is turned off).

"ECU, OPEN DRAPE" the window drapes open — the sun is just beginning to rise. Chris commands "ECU, TEE VEE, JOG". The television screen lights up while Chris adjusts the head of his bed by commanding "BED, RUN". When he is at a comfortable viewing height he commands "STOP".

Soon his mother will come in with breakfast accompanied by his attendant. Dave will bathe, dress and transfer Chris to his motorized wheelchair. Dave and Chris are students at a nearby community college, so Dave will drive to school in Chris' adapted van and will provide any assistance Chris may require during the day. Chris and Dave have now driven to school and Dave has just parked and helped Chris out of the van. Chris will attend classses in his voice controlled motorized wheelchair (Figure 2).

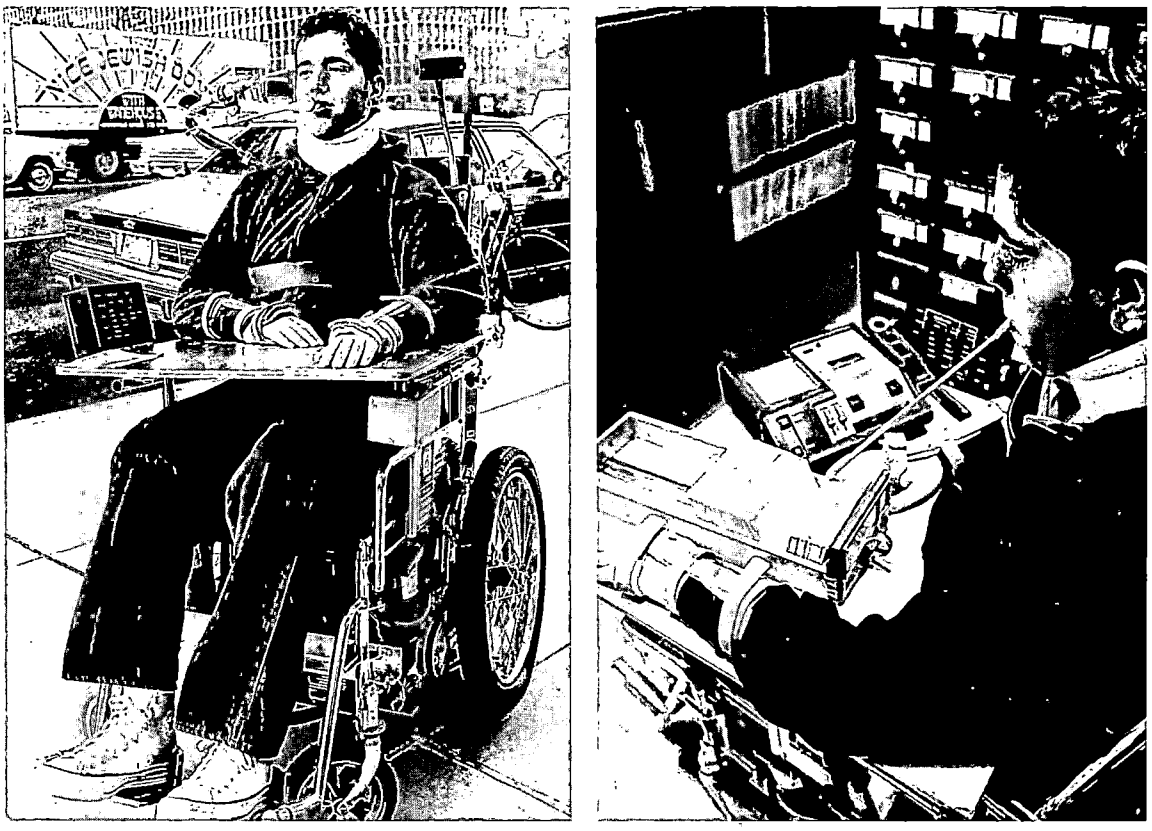
"CHAIR, RUN, FORWARD, RUN". The chair moves forward down the sidewalk and you can hear Chris uttering voice commands to execute the small directional changes necessitated by the uneven terrain. "TURN, LEFT, JOG", to make a small course adjustment to the left or "RIGHT, JOG" to adjust course to the right. As he approaches the ramp into the building he says "FASTER, JOG" increasing his speed up the incline. As he enters the building he reduces speed by com-

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*ECU = environmental control unit

*JOG = "operate"

Figure 2. CHRIS OPERATES HIS VOICE-CONTROLLED POWERED WHEELCHAIR ON CAMPUS SIDEWALK AND IN LIBRARY



manding "SLOWER, JOG, JOG, JOG" which gradually reduces the speed until he is at safe driving speed for the crowded halls and elevators. He moves down the hall; turns the corner by adding the command "RIGHT, RUN", and as the turn is completed he commands "CANCEL" returning to the forward direction. Approaching the door to his class he commands "STOP, TURN RIGHT, RUN, STOP" to align himself with the doorway and then "FORWARD, RUN" into the classroom.

Chris may take notes by utilizing his on-board voice controlled taperecorder. The taperecorder is located under the wheelchair seat and will start to record at the command "TAPE, RUN, RECORD, RUN". Another option he has is to obtain a copy of a classmate's notes — an arrangement that must be made through the handicapped students office.

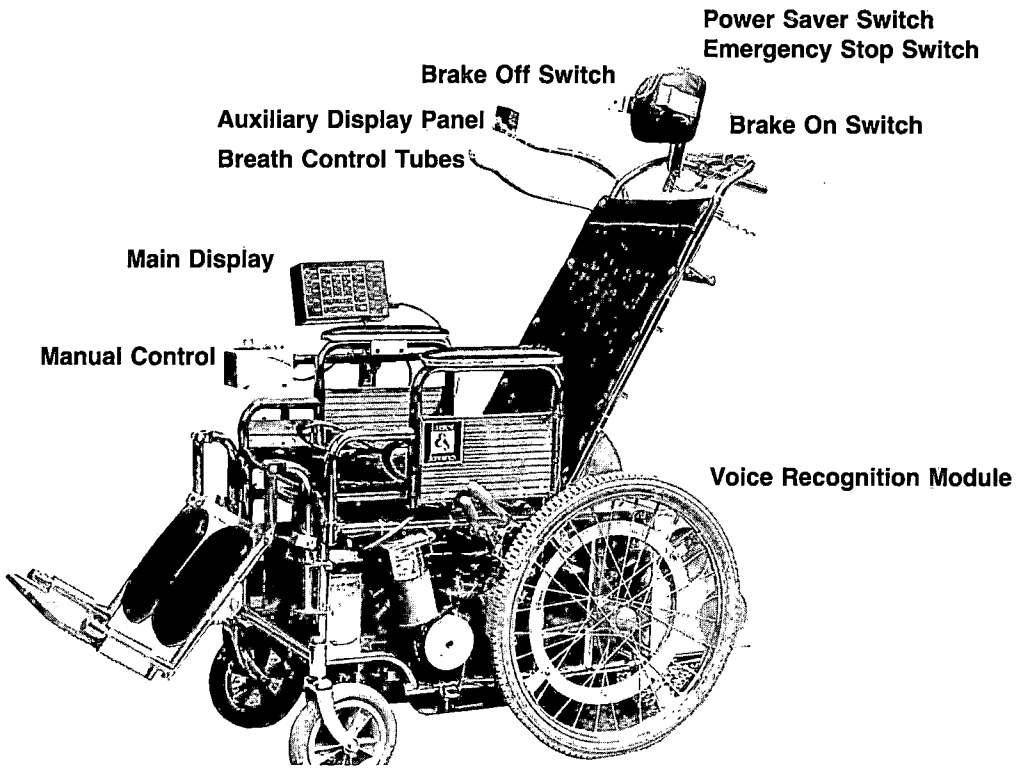
The instrumentation that enables Chris to perform all of the functions described above was designed by the Rehabilitation Engineers at IRM in cooperation with Threshold Technology, Inc. of Delran, New Jersey. (See Figure 3) Voice (speech) control of powered wheelchairs and environmental control instruments is superior to other control modes for several reasons:

- Speech is a natural means of communication.
- Requires no physical linkage between the user and the peripheral device.
- Offers the disabled user maximum degrees of control freedom.
- Can be personalized to accomodate the user's individual needs.[6,7,8]

VOICE ACTUATED INSTRUMENTATION

The present electronic voice control system recognizes 36 commands. The system is initially optimized for the user's speech pronunciation through a short training routine. After training, the system will reliably recognize and execute commands as they are spoken by the operator who trained it. The system can be trained in any language. The commands may even be in the form of meaningless syllables.

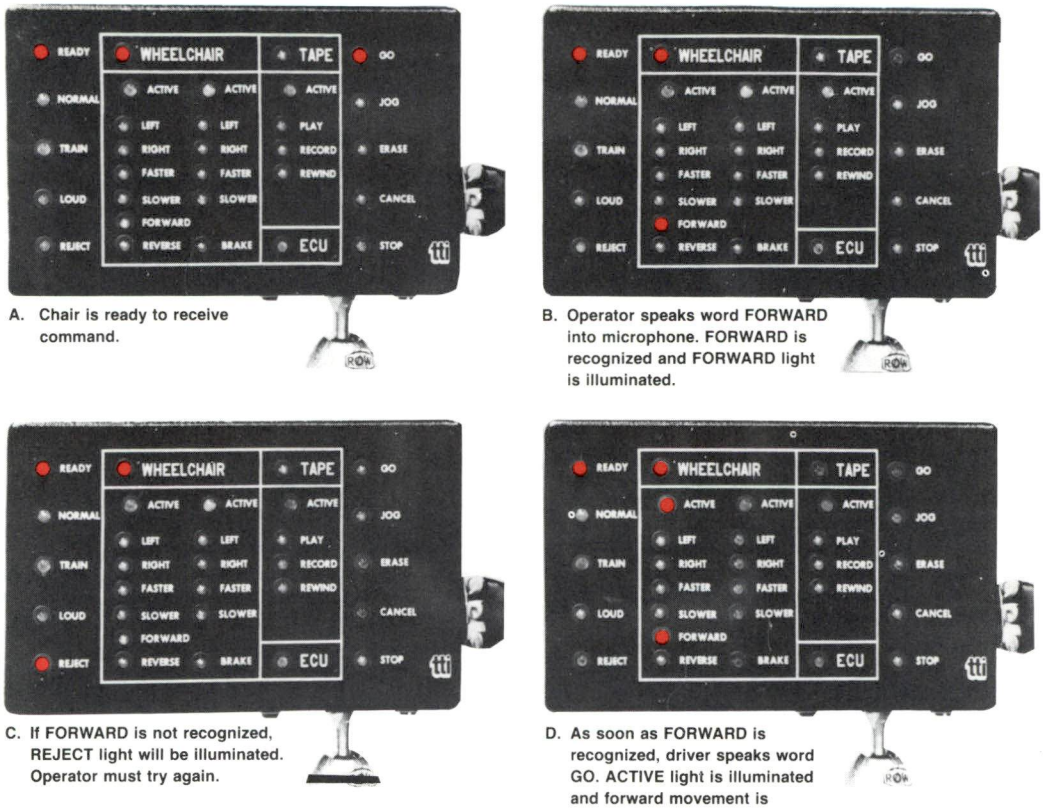
FIGURE 3. LATEST IRM/NYU VOICE CONTROLLED POWERED WHEELCHAIR (back partially reclined and leg rests partially elevated)



Lever in the center of the headrest actuates emergency stop and powersaver switches. The side switches apply or release the friction brakes. The voice recognition module is the white cabinet mounted on the back of the chair. The module is 16″ long x 11″ high x 9″ deep and weighs 34 pounds.

The wheelchair control vocabulary includes directions such as, FORWARD, REVERSE, RIGHT, LEFT, FASTER, SLOWER, RUN, JOG, CANCEL, STOP, ETC. The system operates as follows: The patient utters a command into a microphone. A lamp on a small display panel (shown attached near the right armrest of the chair in Figure 3) is illuminated when the command has been recognized. This allows the operator to verify a command. When one of the action commands is given, the appropriate control circuitry is activated. The two-word command sequence provides protection from misrecognized and possibly dangerous unexpected action, and also permits the operator to change or cancel a command before it is executed. The entire sequence is illustrated in Figure 4. The chair will stop instantly when the driver presses his head lightly against the emergency stop switch mounted at head level — see Figure 3. A pneumatic ("puff and sip") control has been provided to override the voice control system in the event that it is swamped by very loud and continuous external noise; for example, police or fire engine sirens.

Figure 4: COMMAND SEQUENCE FOR FORWARD MOVEMENT OF THE IRM/NYU VOICE CONTROLLED POWERED WHEELCHAIR



A. Chair is ready to receive command.

B. Operator speaks word FORWARD into microphone. FORWARD is recognized and FORWARD light is illuminated.

C. If FORWARD is not recognized, REJECT light will be illuminated. Operator must try again.

D. As soon as FORWARD is recognized, driver speaks word GO. ACTIVE light is illuminated and forward movement is initiated.

The voice controlled environment control system also enables the quadriplegic to answer the telephone; dial a telephone number; operate a page turner; sound a distress call; and perform other functions as required. Usually a few hours of training are adequate to teach a patient to operate the chair and the environmental control system.

Clinical evaluations have been encouraging. It has been most rewarding to learn that ten individuals with cerebral palsy and dysartharia have been able to utilize the voice controlled system as well.

THE INDEPENDENT LIVING LABORATORY

"Bench" testing of instrumentation for the disabled does not provide realistic insight into the functional utility and aesthetic aspects of the devices. It is desirable to establish a model habitat (Independent Living Laboratory) wherein the various environmental control systems are installed in a simulated home or office environment so that they may be operated and evaluated by professional staff and disabled consumers. This facility has proved extremely valuable to the families of patients, home planners, and architects engaged in remodeling of existing apartments or the building of new homes for disabled. One view into this facility is shown in the photograph of Figure 5. A complete layout of the facility is shown in the drawing of Figure 6.

Powered devices are energized directly from "local" 115 V. 60 Hz. receptacles or from remote power receptacles. Wiring from the Environmental Control System (ECS) to each appliance is accomplished with low voltage (12 VDC) wiring similar to that used in the installation of telephones. This system eliminates the need for clustering and lends itself to a very functional and aesthetic layout of the user's habitat or office.

Figure 5: THE IRM INDEPENDENT LIVING LABORATORY.

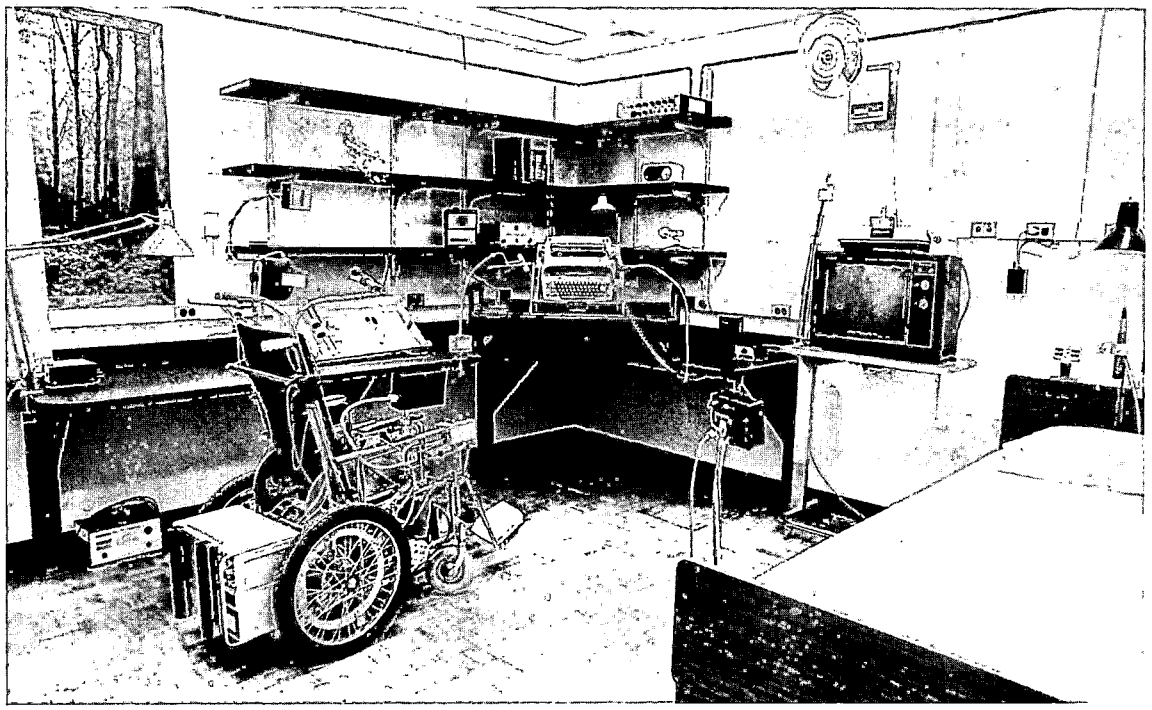
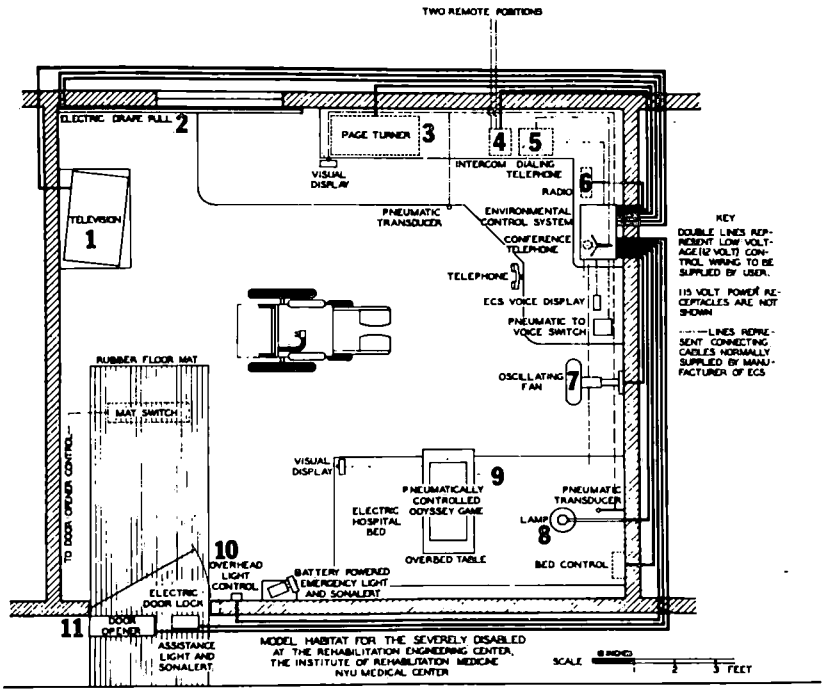


Figure 6: LAYOUT OF FIGURE 5 FACILITY SHOWING ECS CONTROLS

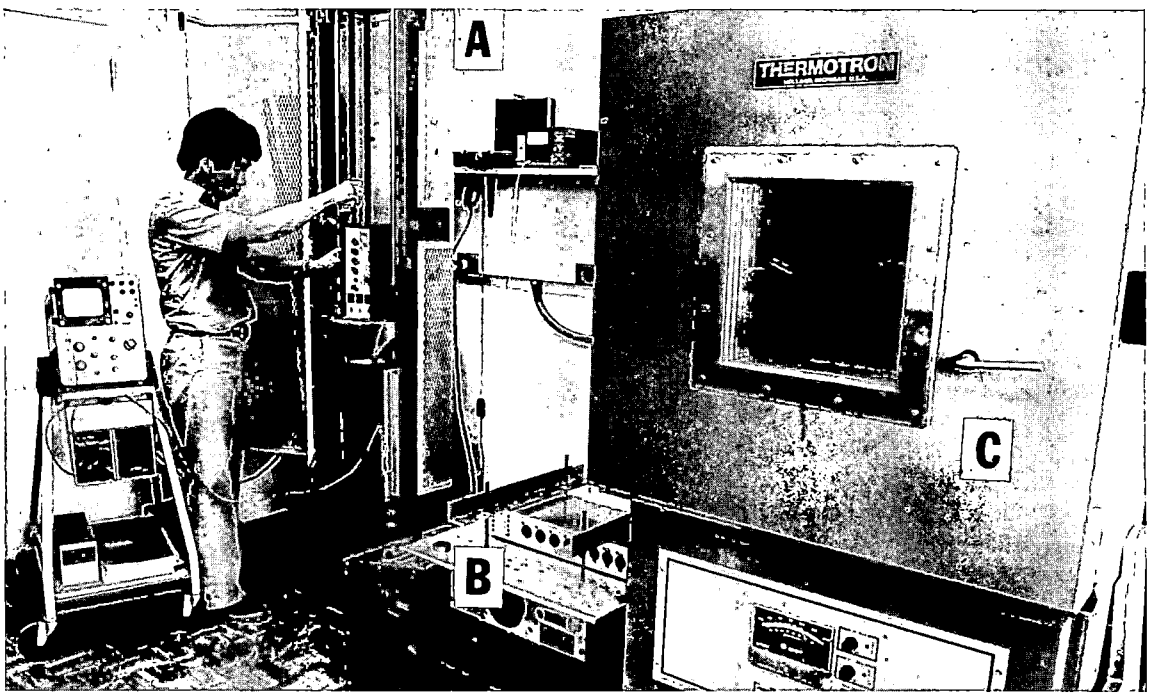
1. Television
2. Electric Drape Pull
3. Page Turner
4. Intercom
5. Dialing Telephone
6. Radio
7. Oscillating Fan
8. Lamp
9. Electric Hospital Bed
10. Overhead Lights
11. Door Lock and Door Opener



THE ENVIRONMENTAL TEST LABORATORY

In addition to the clinical evaluation of electronic assistive devices described earlier, the devices are also evaluated to determine if they perform in accordance with manufacturers' claims, are reliable and safe to use. To meet this requirement, an Environmental Test Laboratory (Figure 7) has been established at the Rehabilitation Engineering Center at IRM. Performance test specifications are developed for the various devices and representative instruments are evaluated. Special attention is given to the detection of electrical assembly flaws (such as stray wire strands, etc.) and defects in insulation which can present a hazard to the user or cause product failure during normal use. Environmental control instruments are also evaluated by accelerated life tests if they are normally required to operate 24 hours per day. Instruments are tested at elevated temperature and humidity if they are required to operate during hot summer weather.

Figure 7: A CORNER OF THE IRM ENVIRONMENTAL TEST LABORATORY



A - Shock Testing Machine, B - Vibration Testing Machine, C - Chamber for testing instrument performance under varying conditions of temperature and humidity.

CONCLUSION

After five years of experience at IRM in clinical evaluation and development of assistive devices, it is the concensus of the project participants, both consumers and professionals, that the result of this research provides new opportunities for increasing the self-sufficiency of the severely disabled. This increased independence has great implication for vocational rehabilitation as well.

ACKNOWLEDGEMENTS

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WHAT MAKES A CARING COMMUNITY?

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At the 53rd Annual session of the American Congress of Rehabilitation Medicine, the distinguished clergyman Harold H. Wilke delivered an impassioned plea for communities to open their hearts and accept disabled persons back into the mainstream of community life. The growing movement toward deinstitutionalization of persons with all sorts of physical and emotional disabilities had impelled Reverend Wilke to call for a closer look at factors supplementary to the individual's own inner resources which can facilitate that person's participation in the ongoing life of society. He felt that a community, to be healing, must not only be tolerant and accepting—which are neutral, passive attitudes of mind—but must also take an active role in incorporating the handicapped unto itself and, thus, must intentionally reach out in love and service to those who are different.

Reverend Wilke proceeded to describe some identifying features of a Caring Society. It permits the handicapped autonomy and independence insofar as possible and, at the same time, it recognizes the interdependence of all members and accepts responsibility for them. A Caring Society attributes value and wholeness to all individuals, no matter how different they may be. It consciously looks for positive aspects in all persons and fully utilizes the unique resources which each individual possesses. Believing all these things, the Caring Community, thus, consciously practices mainstreaming of the handicapped individual, not just in education, but in all ongoing community activities.

According to Wilke's notion, the Caring Community concept reaches beyond the mere absence of physical and attitudinal barriers. It requires the presence of a positive, facilitative, enabling force that actively promotes realization of the disabled person's life goals.

Wilke spoke at an abstract level of communities as entities possessed of attributes and capable of intents, and actions, to promote their members' well being. At a more concrete level, the term community is used in social planning and research to refer to a "home area" in which living organisms function. In addition to an identifiable geographic location, a human community is a network of interdependent and lasting social relationships. People who live in a community are aware of each others' existence. Their feelings and behavior are affected by the presence of others. Their interactions are structured by social institutions, beliefs, values, and customary roles. Strictly speaking, natural physical features do not "care"—only persons "care"—but they do have an effect on behavior and even on feelings of people. In turn, these characteristics of people can and do cause them to modify inanimate features in order to make them more salutary for disabled persons. Thus, in discussing the elements composing a "Caring Community," physical features, established social institutions, and more spontaneous interpersonal relationships must be considered.

In rehabilitation of the spinal cord injured, most efforts in the past were directed toward maximizing the client's physical and psycho-social skills useful for coping with disability. In addition, environmental adaptations are devised to meet the individual client's needs and he is taught techniques for manipulating them. The client's family and significant others are usually included in preparation for discharge, and social/vocational agency resources are contacted on his behalf. In some centers, patients can spend time in a specially created transitional living environment to prepare them for life in their community. After receiving the benefits of the most sophisticated rehabilitation program available, clients are judged ready to resume life in their home communities. Some time after discharge, however, many are re-admitted with problems that appear to have been preventable. We tend to look for the explanation for these problem re-admissions either in some personal inadequacy on the part of the client, such as lack of motivation, or in some failure in the rehabilitation program techniques employed while he was a patient in our facility.

Wilke's plea for a "Caring Community" calls attention to the inadequacies of an exclusive focus on the client. Despite his best efforts, the client may be unable to master his environment and obtain resources necessary for an acceptable quality of life because of problems residing not with him, but in the community itself. On the other hand, the spinal cord injured person who maintains reasonable good health, a high level of social participation, and finds many satisfactions in life despite his handicap, may have been enormously helped by factors in his home community which support him and facilitate this process. A holistic perspective recognizes the interdependence of individuals with their environments and directs attention to the home community as a vitally important element in the rehabilitation picture. An understanding of how key dimensions of community environments affect spinal cord injured persons can help to increase the effectiveness of their rehabilitation programs.

It is evident that communities vary on many objectively measurable dimensions. Size and density, for example, are important determinants of the availability of sophisticated medical services, specialized equipment, and medications, variety in cultural and recreational offerings, and formal organizations for social welfare. Age, ethnic, and religious differences, with their accompanying cultural values, vary from place-to-place, from rural-to-urban, and from one region to another. Different cultural values may be reflected in different attitudes toward disabled persons and may account for the effort a community makes to provide physical and social adaptations for the benefit of the disabled. The presence of a "critical mass" of similarly handicapped persons living in proximity to one another may also contribute to community sensitivity, awareness, and the likelihood of action.

Since communities do vary greatly in so many dimensions, the problem, then, is to identify those characteristics which make a difference in terms of the quality of life for the spinal cord injured person. The purpose of this paper is to examine some of the differences we have observed in our experience with follow-up at the Missouri Regional Spinal Cord Injury System (MRSCIS). We cannot claim that the things we have found represent the best of all possible worlds for spinal cord injured persons. They are, however, those community characteristics which have worked for our "successful" patients. Our intent is not to present definitive findings at this time but rather to emphasize the importance of community characteristics and to stimulate additional investigation.

ABSENCE OF BARRIERS

Integration into the community seems to be gradual. Patients usually begin with situations that are more comfortable or least threatening. They associate with people who seem most accepting and go places where there are fewer mobility constraints. It is then that the distinction between disabled and handicapped becomes apparent. The disabled can be "handicapped" by the presence of both physical (or visible) barriers and attitudinal (or invisible) barriers. Though the focus of this paper is on positive aspects of a "Caring Community," it is important to take note of barriers that constrict the environment and enforce a narrow sphere of activity.

Physical Barriers, such as curbs, steps, unpaved roads, and uneven sidewalks, are one kind of problem that confronts many spinal cord injured persons in their home communities. Lack of mobility is a serious problem for the spinal cord injured individual, for it prevents or greatly impedes his performance of the important roles in his life. Not only is the frequency of social interaction curtailed when a person cannot move about freely in the community, but its nature is changed. Persons, who cannot go out and interact with the world, are forced to wait for the world to come to them. This creates a social dependency which, added to economic and physical dependency, may negatively influence the person's self esteem and self concept, tending to perpetuate the sick or child-like role. Physical barriers that force dependency can affect everything from finding a date for Saturday night to getting and maintaining a job. Freedom of movement among a variety of physical and social settings is advantageous to all persons. Environmental diversity stimulates growth and contributes to enrichment and enjoyment of life.

Not only can the physical barriers in the community "handicap" the spinal cord injured, but so can attitudinal barriers such as ignorance, revulsion, stereotyping, fear, and guilt. For example, some may feel that because the individual is in a wheelchair, he has impaired mental capacity. This happened when one of our patients returned to his high school and the principal questioned his ability to meet the normal academic requirements. These attitudes actually encourage the stereotype of the disabled person sitting at home, dependent and non-productive. A barrier-free environment, then, allows the spinal cord injured person to be himself and live up to his potential. But this process is undoubtedly facilitated by positive features present in some communities.

PHYSICAL FEATURES

Of course, some physical features of communities are not under the control of community members, but compensation can be made for negative features and positive ones can be created through cooperative effort. The natural environment, man-made environmental elements, and population characteristics, particularly size, can have an impact upon the patterns of interaction which arise among residents and upon the basic institutions and associations that evolve. About two-thirds of MRSCIS patients return to small towns and rural communities with populations under 15,000. Less than a tenth of our patients live in large urban centers and suburbs—the remainder live in medium-sized towns and cities. Thus, the descriptors of "Caring Communities" we will identify tend to be representative of the rural Midwest culture.

It seems obvious that a mild climate permitting year round outdoor wheelchair navigation and a relatively level topography can matter a great deal in terms of mobility for the SCI person. They directly affect the amount of out-of-home activity possible. Although the winters in some parts of Missouri are more severe and confining than in others, there is generally not enough difference to motivate patients to move from one Missouri community to another in search of warmer weather. Resources available for coping with climate and modifying its effects seem to be more important to our patients. For example, lack of accessible transportation is a major problem in post-hospital adjustment for many of our patients. The cost of modifying cars and vans and purchasing insurance for a handicapped driver are considerable. Ordinary public transportation, even if adapted for wheelchairs (which is the exception), is an inadequate solution to the mobility problem of the spinal cord injured because buses or trains do not run close enough to most residences to be of use. The disabled cannot travel long distances to reach a bus or train—curbs, steps, and crowds are major obstacles. An excellent solution is provided by buses and minibuses, adapted for the handicapped, that pick up and deliver the client to his door. Communities which have agencies providing this type of transportation system have made it possible for some of our patients to attend college and for others to work in sheltered workshops and vocational evaluation centers. However, the

agency-run adapted buses are only feasible in larger communities where a number of handicapped persons need the service. Rural and small town patients have to depend on family and friends to lift them in and out and to drive them to their destination until such time as they are able to get their own modified vehicle.

Those of our patients who live in communities with accessible malls containing a variety of shops, services, and entertainment get out of their homes far more often regardless of the weather. In fact, our spinal cord injured clients will travel 25 to 30 miles to reach such a mall. Once inside, they find an opportunity to engage in many activities independent of the person who transported them. Even in the absence of a climate protected mall, accessible businesses and buildings greatly facilitate the independence of spinal cord injured persons. To be able to attend to banking and other business, go to the post office, get a haircut, and do one's own shopping from a wheelchair, means spinal cord injured persons will do these things themselves and thereby retain a certain amount of control over their lives, rather than allowing parents or spouse to assume the responsibility. Nevertheless, many of our patients do depend on fellow students or family to maneuver them in and out of entrances and up and down stairs.

The impact of accessible recreation opportunities in the community is greatly dependent upon the spinal cord injured person's recreational interests prior to injury. For example, those of our patients who were active in team sports before injury find that even if they cannot physically compete in the games they enjoyed before, they can still feel a part of the action as spectators. Because the spinal cord injured were visible members of the sports setting pre-injury, they and their friends work to get alterations made in facilities (such as the high school gym, the ball park, and the bowling lanes) when SCI victims return to their communities.

Most of our patients from rural Missouri enjoyed hunting and fishing before injury and will arrange modifications for their own boat and equipment so they can continue. Of course, in the absence of accessible commercial recreation, or of transportation to natural outdoor settings, many spinal cord injured persons spend more time in passive forms of entertainment—beer drinking in bars or at home, and solitary television watching—than they did before their injury.

SOCIAL SUPPORT SYSTEMS

Social support systems play a significant part in maintaining the physical and psychological integrity of persons in society. Support systems are relationships providing help to the individual in meeting daily material and emotional needs as well as special needs in time of crisis. Informal support systems are composed of kin, friends and neighbors who interact with the individual on a spontaneous personal basis. Formal support systems are bureaucratic organizations which function instrumentally and objectively to meet specific limited needs.

The extent to which the spinal cord injured person can depend on an informal support system is related not only to his or her personal qualities and the size of the friendship group but also to cultural values present in the family and community. Persons who were part of a large close knit family before injury continue to find the family a source of support. There are differences, however, in the willingness of members of the immediate family to disrupt their own lives in order to provide daily attendant care for a spinal cord injured relative. We have found female relatives from black inner city neighborhoods often have health related occupational experience and are willing to rearrange their living accommodations to care for their spinal cord injured kin. This has also been true of rural lower socio-economic level whites. One can speculate that traditionally matriarchal families, where women are strong and men more often have health, alcohol, and unemployment problems, adapt readily to the dependency of the spinal cord injured male. On the other hand, we have observed in some of our families of higher socio-economic status that occupational mobility norms interfere with family support for the patient, whether male or female. If paid attendant care

cannot be obtained, the family becomes disrupted. As another illustration, we have found that while urban families have difficulty making home modifications to accommodate wheelchairs because they cannot afford the expense or are not permitted to alter rented dwellings, rural families do not seem to be daunted. They either have the skills themselves or can call on persons in their support systems. Rural know-how plus a tradition of cooperative effort and a feeling of mutual concern compensate for the absence of technical resources.

Clients usually return to their pre-injury peer group, at least initially. Popular students find that fellow students compete for the chance to help them up and down stairs and conduct fund drives to buy them special equipment. Patients smile with pride when they return from a therapeutic home visit and tell us that their classmates held a dance in their honor to help raise money for a van or that the neighbors got together and built a ramp. In these situations, the disabled do not feel like objects of pity or "charity cases". They have been proud of their community and the fact that they are well enough regarded and have enough friends to organize these activities. For other young spinal cord injured persons, returning to the peer group may involve returning to "street" values and the lifestyle which predisposed them to injury. These patients seem to be happy as they are expressing their own values and their disability may justify lack of occupational accomplishments.

Another type of informal support is received by some clients when they form a common interest group of similarly disabled individuals. Newly injured persons experience anxiety about going out in public in their home towns. Many of our patients have said that they have never seen another person in a wheelchair in their town. Aware of how conspicuous they will be in their wheelchairs, they are self concious about interaction with the able bodied. However, when there are enough other wheelchair bound persons living in the community, a group may form which gives individual members confidence and the courage to be assertive in making demands on society. It multiplies the visibility of the disabled in the community and serves as a pressure group to get things done. The group also provides understanding, emotional support, and opportunity for shared problem solving. In fact, we have seen more than one situation where one spinal cord injured person lived for years virtually house bound until another person in his home town became injured. Then, the two men became allies and were able to obtain several improvements in their community's accessibility.

It is not a new observation that larger urbanized communities possess social systems more complex, more formal, and more impersonal than those of rural communities. Urban dwellers depend upon formal bureaucratic organizations to meet many of the daily needs that in small communities are met by neighbors, kin, and churches.

Large communities have advantages in that they provide a greater range of employment opportunities, commercial goods and services, and formal human service agencies. They are more likely to have the specialized services, equipment and supplies that the handicapped person needs. Medical care is likely to be more sophisticated in management of spinal cord injury problems. Having these services nearby and convenient sometimes makes the crucial difference in whether a client can be gainfully employed. Certainly less time and expense are required to maintain health status in large communities where these are available, and that allows greater freedom for other activities. Patients in rural areas spend more time returning to the rehabilitation center for equipment, supplies, and medications. The lack of ready availability does not necessarily result in neglect. Patients who cannot obtain their prescriptions nearby, however, often stop taking their medications. Patients may allow conditions to deteriorate before seeking help if local health care providers are not knowledgeable about spinal cord injury problems.

Small communities compensate for having fewer formal services by utilizing informal networks and quasi-formal voluntary associations to accomplish the same things. Groups like the Jaycees and the Eagles provide a great deal of help to community members in need, especially to their own members and relatives. These associations, along with the churches, play a major role in the

social life of small towns. Their meetings provide a structured occasion for conviviality and recreation where there are few alternatives available. Moreover, they reinforce the community residents' in-group identity. Members of these groups are likely to accept the disabled person because he is perceived as one of the in-group despite the changed appearance of his body, and they feel a sense of responsibility for one of their own. Voluntary associations in the small towns are enthusiastic organizers of fund raising events; for example, benefit bake sales, dances, and chili suppers. Such events were held to raise money for a patient's mother to make several 536-mile round-trips to our rehabilitation center to learn her son's care routine.

Rural bible belt churches have traditionally reached out to embrace members and the church bus is an institution of long standing. Our clients' home town churches are usually the first to make alterations so their buildings will be accessible after the injured person returns. Spinal cord injured patients have often been asked to speak at the churches to provide inspiration and furnish an example of a person's ability to overcome obstacles.

In small communities, then, choices are limited in many of life's domains. We have found, however, that the resources these communities do have are employed more flexibly to accommodate spinal cord injured persons. Individual employers, for example, are less confined by bureaucratic regulation. Moreover, the rural tradition of communality and mutual responsibility means that people are more willing to exert effort on the disabled person's behalf.

RESPONSIBILITY OF THE CLIENT

Client participation in setting and attaining goals is part of the rehabilitation philosophy. They are encouraged to participate in the community as well as in the rehabilitation facility. The participation of the disabled person is needed in order to identify the components of a "Caring Community." The spinal cord injured individual is the only one who can really say what he needs and his is the responsibility to make the community "aware" of these needs. Without this input, misunderstandings between the client and the members of the community, regarding the role and needs of the disabled, may occur.

There are several ways a spinal cord injured person can contribute to making a "Caring Community." One is that, more than anyone, he needs to be aware of his rights, and of laws regulating barriers. His assertiveness as an informant and educator can then help in getting these barriers removed. This may mean that the client has to become active in community affairs and participate in city planning meetings. When members of the community are informed, there are fewer problems in getting changes implemented, especially in the smaller communities where this can be done on a more personal level. Besides active participation in planning, the spinal cord injured can write letters and publicly give their opinions. For example, when a new building is being constructed, the architects may need to be reminded of the needs of the disabled. Family members and significant others can be encouraged to do the same. Most of all, those with spinal cord injuries can be visible and attend community and recreational activities to show that they desire to participate.

The "Caring Community," then, can best be achieved with the active participation of the client. His involvement can eliminate negative stereotypes and diminish pity, repulsion and other attitudinal barriers discussed previously. Generally, we have found that the public does respond to educational efforts and suggestions of the client and his family.

(continued on page 47)

SIMULTANEOUS, CARDIOVASCULAR, ELECTROMYOGRAPHIC AND URODYNAMIC EVALUATION OF PATIENTS WITH SPINAL CORD INJURY

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Urinary difficulties comprise the most common complications following spinal cord injury[1,2,] with acute inflammation and urolithiasis being the most common. Historically, therefore, strict attention has been directed to this system of the spinal cord injured individual. At present, most physicians agree that part of the comprehensive evaluation of the patient with spinal cord injury should include a complete urological evaluation. As a result of prevention, early detection and vigorous treatment, urinary tract difficulties are no longer the first cause of death among the patients with spinal cord injury[3,4,5,6]

In many institutions, the urological evaluation customarily includes an intravenous pyelogram and a voiding cystourethrogram in addition to the chemical and bacteriological analysis of the urine; the hydrodynamic evaluation of the urinary bladder is being increasingly included in this workup. The merging of cystometry with the later developed electromyographic study of the external urinary sphincter[7,8,9] provides a physiological provocative test of vesico-sphincteroruethral function.

The electromyographic urodynamic study offers information on the relationship between the pressure and the volume of the urinary bladder, and on the status of the synergy between theeliminatory attempts of the bladder and the function of the external urethral sphincter. These electromyographic studies of the urinary system offer the clinician a more "true to life picture" of the function of the urinary tract, namely the storage of urine and its expulsion at a specific time. This is of particular significance in the spinal cord injured patient since urinary tract dysfunction is primarily neurogenic.

In our laboratory, we have used this test not only as a detector of difficulty but also as a means of understanding how bladder emptying is achieved in the spinal cord injured person. This is illustrated in Figure 1 which depicts the results of the urodynamic studies on a patient before and after anterior rhizotomy.

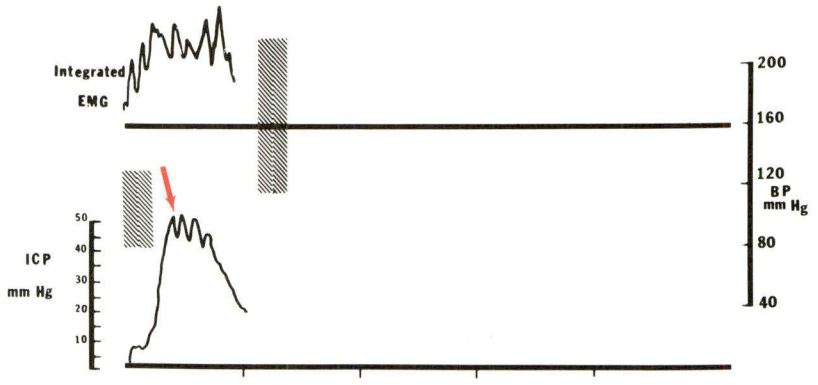
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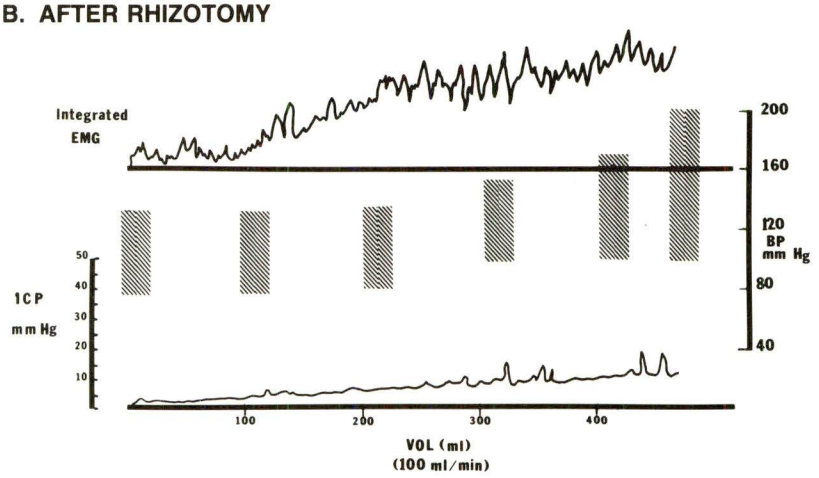
** Research Assistant, NERSCIS.

Figure 1. CARDIOVASCULAR, URODYNAMIC AND NEUROPHYSIOLOGICAL STATUS BEFORE AND AFTER RHIZOTOMY

A. BEFORE RHIZOTOMY



B. AFTER RHIZOTOMY



LEGEND: The intracystic pressure tracing (ICP) is expressed in millimeters of mercury. The horizontal axis shows the volume (m1) of gas instilled into the bladder at a filling rate of 100-m1/minute.

In A, the intracystic pressure rises sharply at approximately 50 ml of bladder filling. Marked detrusor contractions and leakage of gas around the catheter occurred. (see red arrow) The electrical activity of the sphincter is grossly hyperactive and dyssynergic. The blood pressure response was dramatic, rising from 120/80 to 220/120.

Following the anterior rhizotomy (B), the bladder was able to accept up to 500 ml without a significant rise in pressure or leakage around the catheter. However, the external sphincter continued hyperactive and dyssynergic. The blood pressure response continued to be dramatic, rising from 120/84 to 200/100. This indicates that the sensory volleys from the distended bladder into the spinal cord still persisted. Obviously, this sensory bombardment was still causing the hypertensive response.

In the last year, we have become more aware that a not insignificant number of patients with apparently acceptable bladder function develop vague complaints at the time of bladder emptying. These are nonspecific—mild sweating, cutis anserina, coldness, slight chills and at times headaches. They have also been observed by others.[10, 11] Despite our suspicions that these phenomena were due to peripheral vascular difficulties, the physical examination was unremarkable and the

blood pressure was within the normal range. Obviously the disturbance was significant enough to produce symptoms and signs but transient enough to escape the usual examination techniques. It became obvious that the hydrodynamic and electromyographic examination of the bladder and the sphincter was not providing a complete picture of the bladder emptying function in the spinal cord injured person. Since these nonspecific occurrences tended to implicate the cardiovascular system, we decided to study the cardiovascular response during bladder emptying in our patients. The purpose of this study was to examine the cardiovascular response associated with the progressive bladder filling and bladder emptying in patients with spinal cord injury.

METHODS AND PROCEDURES

The urodynamic studies were carried out using a carbon dioxide medium. The pressure of the gas from the tank was reduced by means of a valve. The pressure was reduced to less than five pounds per square inch. The gas was then fed into a flow regulator (Model R-1, Applied Electrochemistry, Inc.). This flow meter—accurate to ± 2-ml/minute—was calibrated at two different rates, 50-ml and 100-ml per minute. The carbon dioxide was delivered through surgical latex tubing with an inside diameter of ¼" attached to a "Y" connector. One arm was connected to a Statham P 23 ID pressure transducer in series with a urinary trap and then to a #18 Foley catheter. The other arm of the "Y" connector was affixed to an aneroid manometer which served as an instantaneous visual feedback of the pressure in the system. The signal from the pressure transducer was fed into a DC amplifier module of a Grass Polygraph Model 7 D.

The motor unit action potential of the external urinary sphincter was obtained by using a two-inch bipolar needle electrode placed percutaneously into the external urinary sphincter. The electromyographic signal was amplified by a Teca Electromyograph Model M and displayed on its oscilloscope. In addition, the signal from this recorder was fed into a DC amplifier module of the Grass Polygraph. The signal from the module was then fed into an integrator module which supplied output as the integral of the motor unit action potentials (Integrated EMG).

The intracystic pressure, the direct EMG signal and the integral of that signal were fed into recorders and permanent traces were made for future reference. In addition, the signals of the intracystic pressure and the integrator were passed through a Hewlett Packard 47310 Analog to Digital Converter and fed in a Hewlett Packard programmable calculator (HP 9815 A). This calculator obtained a sample of each of these two channels every two seconds, feeding those signals into a Hewlett Packard X-Y Plotter Model 9827 A. The integration period was adjusted to approximately ⅛ of a second in order to ensure that continuous sphincter activity was being integrated and not spurious signals.

Following a complete and detailed explanation of the entire procedure, each patient was examined with particular attention to the neurological examination of the perineal region. Information on the status of the perineal reflexes, sensation and the presence or absence of volitional activity of the pelvic floor was carefully recorded. An #18 balloon Foley catheter was then inserted using strict aseptic technique. The residual urine was withdrawn, measured and, when appropriate, a sample was sent for culture and sensitivity studies.

The motor unit action potential of the external urinary sphincter was recorded with a bipolar needle electrode placed percutaneously. The entire perineal region was cleansed with Betadine and alcohol. The lower border of the posterior surface of the prostate was located by rectal examination. The needle electrode was then carefully placed and directed toward that area. When the tip of the needle entered the external urethal sphincter, the motor unit potential became crisp, short in duration and high pitched in sound. The location of the needle was confirmed by repeating the eliciting stimuli for the bulbocavernosus, the anal and the urethral reflexes. When the needle was properly placed, these stimuli produced a sudden short burst of increased motor firing.

Following these preparations, the resting, systolic and diastolic blood pressures were recorded using a mercury manometer on the right arm. The heart rate was obtained by direct auscultation of the apical arm. The heart rate was obtained by direct auscultation of the apical pulse. Subsequent blood pressure and heart rate were obtained for every 100-ml of instilled volume. These values were then entered into the XY Plotter at the completion of the test.

RESULTS

Forty patients were studied using the described protocol. Twenty were quadriplegics with a mean age of 22.5 ± 4.0 years*; the 20 paraplegics had a mean age of 31.8 ± 12.1 years. These patients were studied while on medication used to enhance bladder function. The decision to study them while on medication was based on the fact that this represented reality and, in most patients, represented the combination of medications considered to be clinically optimal.

The average bladder capacity for the paraplegic group was 444 milliliters. The average capacity for the quadriplegic bladder was 359 milliliters. The volume at the initial detrusor contraction occurred much earlier among quadriplegics than among paraplegics. In the quadriplegic group, this occurred at 117.5 ml while in the paraplegic it occurred at 175.6 milliliters. This difference is significant ($P < 0.05$) and may indicate that a lesser stimulus is necessary to elicit a contraction in the quadriplegic detrusor than in the paraplegic one.

Analysis of the hydrodynamic and electromyographic data for the entire group showed a clear distinction in the response thus, allowing a categorical separation (See Table 1).

1. Detrusor hyperreflexia and hyperreflexia of the external urethral sphincter.
2. Detrusor hyperreflexia in the presence of a denervated external urethral sphincter.
3. Urethral areflexia in the presence of denervated sphincter.
4. Detrusor areflexia with an hyperreflexic external urethral sphincter.

Table 1. DISTRIBUTION OF HYDRODYNAMIC AND EMG SYNERGISM

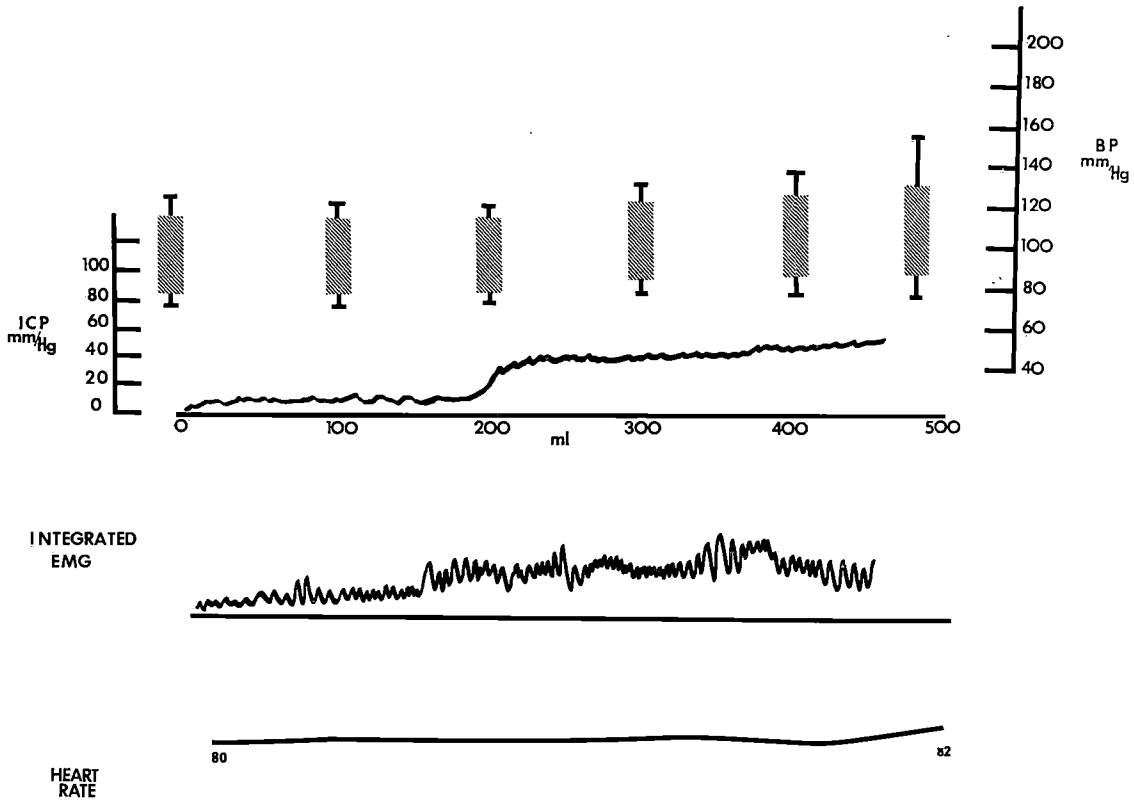
DETRUSOR HYPERREFLEXIA HYPERREFLEXIA OF THE EXTERNAL URETHRAL SPHINCTER N = 29	DETRUSOR AREFLEXIA DENERVATED URETHRAL SPHINCTER N = 2
DETRUSOR HYPERREFLEXIA DENERVATED EXTERNAL URETHRAL SPHINCTER N = 0	DETRUSOR AREFLEXIA HYPERREFLEXIA EXTERNAL URETHRAL SPHINCTER N = 9

Figures 2 and 3 show a composite tracing of the urodynamic, electromyographic and cardiovascular evaluation of the entire paraplegic group and of the paraplegics with conus lesions respectively; the blood pressure and heart rate values used are the averages. The cardiovascular changes in response to bladder filling among the quadriplegic group were far more striking than those for the paraplegics. These are shown in composite Figure 4.

The heart rate response was different between the two groups. The initial heart rate in both, was 72 beats/minute. However, the heart rate dropped to 65.5 beats/min. among quadriplegics while

*± Standard Deviation (SD)

Figure 2. COMPOSITE RECORDINGS FOR TWENTY PARAPLEGICS DURING PROGRESSIVE BLADDER FILLINGS AT 100 MILLITERS PER MINUTE



LEGEND: The intracystic pressure tracing (ICP) is expressed in millimeters of mercury and was taken for one representative subject. The integrated EMG tracing of the external urethral sphincter was similarly obtained for one representative subject. The systolic and diastolic blood pressure shown by the bars represent the mean for the paraplegic sample. The vertical lines represent the standard deviation for each mean. The heart rate is indicated by the solid line. In response to bladder filling, an increase in the electromyographic activity of the external urethral sphincter was noticed. The firing is dyssynergic, evidenced by the increase in electromyographic activity in response to the detrusor contraction. The blood pressure response was not significant.

it rose from 72 to 82 beats/min. among paraplegics. The difference between the end points was significant. The blood pressure at the peak bladder filling rose to 131 ± 14/77 ± 10. The blood pressure at the peak bladder filling rose to 131 ± 24/84 ± 4. This rise barely achieved significance ($P = 0.05$).

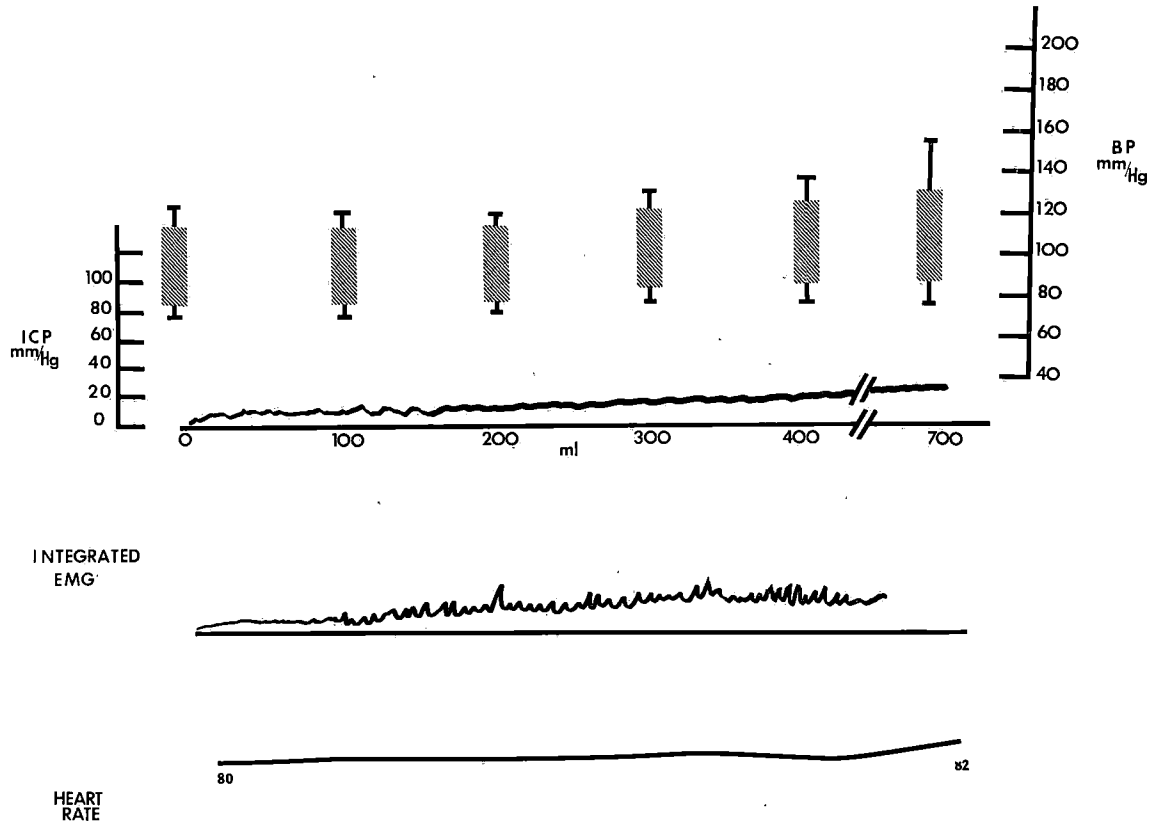
The initial blood pressure in the quadriplegic group was 115 ± 12/70 ± 11. The blood pressure at the peak filling rose to 173 ± 20/101 ± 15. This difference is highly significant ($P < 0.001$).

DISCUSSION

In man with an intact neuraxis, autonomic nervous system reflexes are modified and regulated by higher central nervous system centers. Transient changes in non-spinal cord injured persons have been observed in response to altered tone of a hollow viscus. Sturup[12] reported vasoconstriction in the toes and to a lesser extent in the fingers following distention of the esophagus. Carmichael, Doupe and McSwiney[13] demonstrated that distention of the duodenum produced the same result. Abramson[11] noted that in the normal person, prior to the emptying contraction of the urinary bladder, the "blood pressure and heart rate rise a little only to return to normal with drop in intracystic pressure".

Following interruption of the spinal cord particularly at levels cephalad to T-1, there is altered physiologic response due to absence of higher center influence on spinal sympathetic outflow.

Figure 3. COMPOSITE RECORDINGS FOR A SUB-GROUP OF SIX PARAPLEGICS WITH CONUS LESIONS DURING PROGRESSIVE BLADDER FILLING AT 100 MILLITERS PER MINUTE



LEGEND: The parameters for the vertical and horizontal axes are similar to those in Figure 2. Notice that a progressive increase in the firing of the external urethral sphincter is evidenced by an increase in the integrated EMG. The intracystic pressure did not show any detrusor contraction up to a volume of 700 millimeters. The blood pressure and heart rate response was not significant.

Sherrington[14] noted a sharp rise in blood pressure in a spinal cat associated with gall bladder distention. Head and Riddoch[15], over six decades ago, reported findings consistent with autonomic hyperreflexia. Its anatomical basis was graphically portrayed by Kurnick[16].

Our paper is concerned with an understanding and elucidation of those manifestations of the high spinal cord injured individual with subtle, transient, cardiovascular findings. Though not consistent with the well-recognized manifestations of autonomic hyperreflexia they are, nevertheless, worthy of consideration because of their usually unrecognized existence and their potential danger.

In 1966, Abramson[11] opined that to study the mechanism of voiding and its effects, one must look at the total organism. He suggested that what is needed is a combined method of recording from the subject. Such a method would not only record the pressure of fluid within the bladder but also the action of the sphincter, the blood pressure and heartbeat which change with bladder filling and contraction.

In describing an early sole traditional method of bladder study, cystometry, which had originally been described by Deboise in 1876[17], Munro[18] noted that it was possible by retrograde filling to determine the functional activity of the bladder, but, as a method of examination, it was not claimed to be, and could not be, more than relatively exact. He felt that when carefully applied, there could be obtained the curve of the basic tonus, the normal capacity of the bladder, the residual urine volume and the pressure of emptying contractions. To cystometry, he added sphincterometry

wherein it was possible to measure resistance to the passage of a stream of fluid directed intraurethrally against the external face of the external urethral sphincter.

Later refinement of cystometry made possible demonstration[19] of four stages of cystometric tracing: a resting or filling phase, pre-voiding phase, a voiding sequence and a post-voiding phase. The availability of electromyography provided a refinement in the study of sphincter action including its mode of activity in the sequence of bladder emptying.[7,8,9]

Prior to carrying out assessment by this study's method, which allows concurrent observation of bladder and sphincter activity along with cardiovascular adaptations, we could only speculate on the basis of the transient complaints of our high spinal cord injured patients. We are accepting Abramson's[11] dictum: "The bladder does not exist as an independent structure; it is part of a highly complex mechanism. It is important to study as much of this reflex mechanism as possible and not just to concentrate on the bladder."

This is demonstrated by the case shown on Figure 1. Notice that in this quadriplegic patient there was severe detrusor hyperactivity and a very small capacity bladder. Following anterior rhizotomy there was complete motor denervation of the bladder. Repeated neurological studies showed this clearly; motor denervation of the bladder was evidenced by the fact that the bladder was able to accept a high volume without detrusor contraction. However, the blood pressure change in response to bladder filling showed that sensory volleys were impinging upon the cord and, eventually, produced the massive vasconstriction.

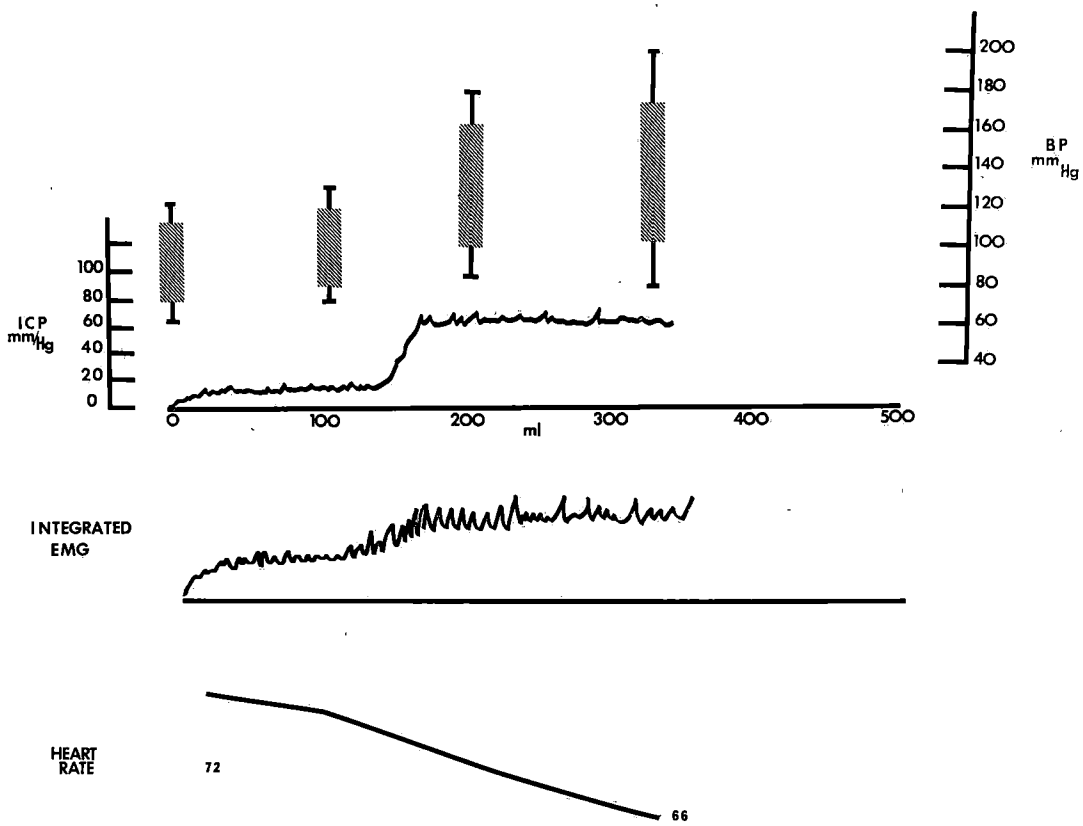
The quadriplegic's response is significantly different from the paraplegic's. These changes are depicted in Figure 4. Notice that in response to the distention of the bladder, there is a marked rise in the systolic and diastolic blood pressures. At the peak, the average blood pressure for this population was 173/101. This rise is statistically significant.

The reciprocal change in the heart rate in response to the rise in the blood pressure deserves mention. In response to the distention of the bladder, the quadriplegic's disassociated sympathetic system responds with massive vasconstriction which is manifested by the dramatic rise in blood pressure. This profound change is detected by the carotid and aortic sinuses. Their sensory input will impinge upon the brain stem, being carried via the 9th and 10th cranial nerves. These impulses will impinge upon the motor nucleus of the Vagus which will, in turn, produce a profound bradycardia. This marked drop in heart rate though poor as a compensatory mechanism, is an attempt to control the pressure within the vascular system, and is the only compensatory mechanism left for the quadriplegic. Nevertheless, if profound enough, this may result in severe bradycardia with an eventual sinus arrest, as illustrated by the following case.

JM, is a 26-year-old male C5 quadriplegic, since a diving accident in 1979. Automatic bladder emptying was achieved shortly after the injury. Since then he has remained catheter free. Following a complete rehabilitation program, he was discharged home. Six months later, he was readmitted for a urological evaluation. While obtaining his history, he mentioned that he had noticed that shortly before the bladder emptying, he tended to develop sweating, shaking chills and occasionally pounding headaches. The episodes would last several minutes disappearing suddenly. On further questioning, he mentioned that these episodes occurred 5 to 10 times daily.

The urodynamic, electromyographic and cardiovascular study was performed. The results are depicted in Figure 5. In response to bladder filling, there was an increase in the electromyographic signal. The initial blood pressure was 117/80 but, at peak bladder filling, it rose to 200/100. At that point, he developed the same discomfort he had been experiencing several times a day. The heart rate which was initially 56 dropped markedly to 32 beats per minute. The test was repeated, this time with electrocardiographic monitoring. At the time of peak bladder filling, the response was similar. He developed a first degree AV block with lengthening of the PR interval to 0.26 seconds. This response should serve to point out the need for careful attention to the cardiovascular response

Figure 4. COMPOSITE RECORDINGS FOR QUADRIPLEGIC SAMPLE DURING PROGRESSIVE BLADDER FILLING AT 100 MILLITERS PER MINUTE



LEGEND: The ordinate and abscissa are similar to those in Figure 2. Notice the early rise in the intracystic pressure due to the detrusor contraction. The dyssynergic pattern is evidenced by the rise in the electromyographic firing. Observe the dramatic rise in systolic and diastolic blood pressures along with the reciprocal drop in heart rate. (see text).

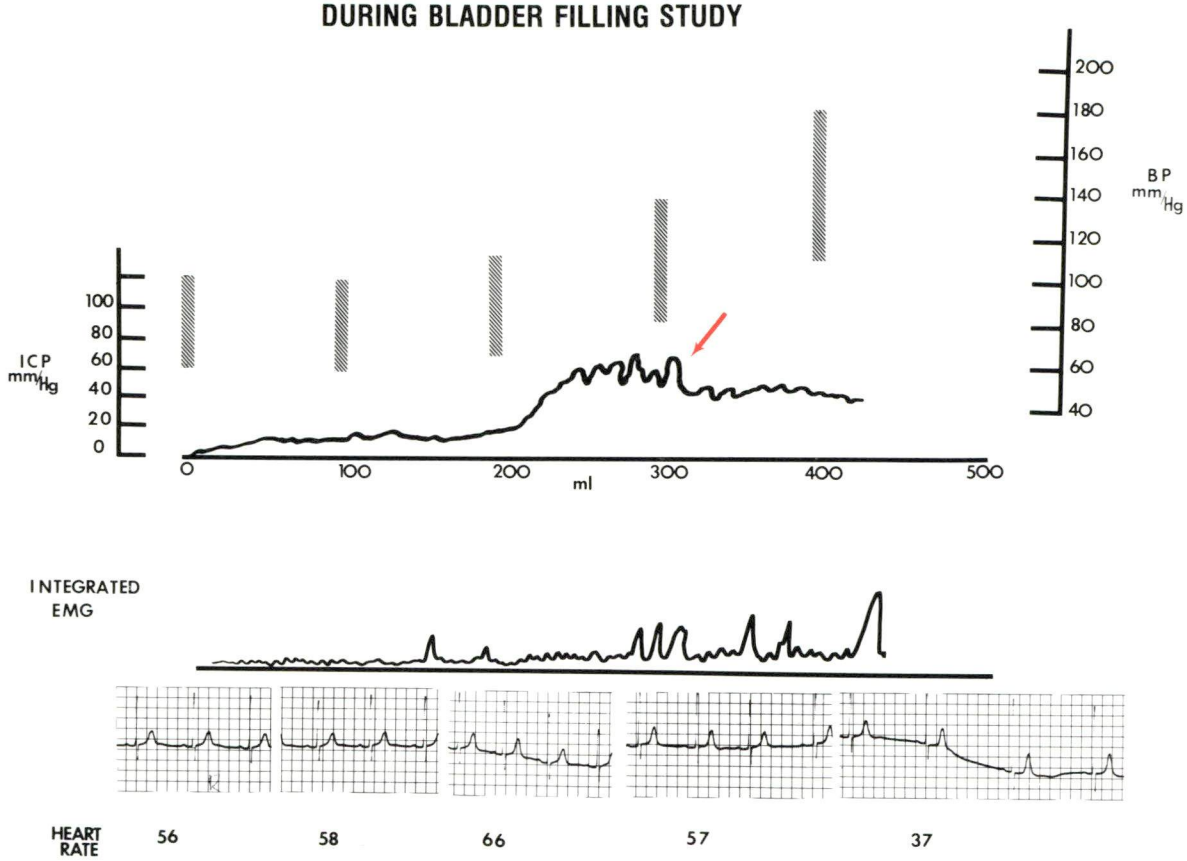
to bladder filling in the spinal cord injured person. The impact of the sensory bombardment from a distended bladder on a disinhibited spinal cord should not be underestimated.

The compensatory cardiodecelerator response if strong enough may result in sinus arrest and was most probably the mechanism of death in the following patient. CB was a 27-year-old male C6 quadriplegic as a result of a motor vehicle accident in 1970. He achieved successful automatic bladder emptying and was placed on external urinary drainage. On a few occasions, episodes of autonomic dysreflexia developed accompanying infection and, on one occasion, was due to decubitus ulceration.

During these episodes, his blood pressure response recorded in the range of 136-172/82-100, was far less dramatic than the change in his heart rate. The heart rate on those occasions would usually drop to 44 per minute. After an initial intensive rehabilitation program, he was discharged home. He was followed regularly with special attention to his urological evaluation.

In November of 1977, he contacted a resident physician by telephone, complaining of an increase in sweating and development of chills several times a day. These episodes were mostly related to bladder emptying. In addition to these complaints, he mentioned that he was constipated and had not had a bowel movement in several days. He was advised to come to the outpatient clinic. Four hours later, we were notified that he was dead. Since the medical examiner waived post-mortem examination, the apparent cause of his demise was not determined.

Figure 5. URODYNAMIC AND CARDIOVASCULAR STATUS OF JM DURING BLADDER FILLING STUDY



LEGEND: The ordinate and abscissa are similar to those in Figure 2. After 200 ml of bladder filling, a sudden rise in the intracystic pressure was noted with spasmodic contraction of the detrusor muscle. The red arrow indicates the point of gas leakage around the catheter. In response to bladder filling, a dramatic rise in blood pressure, up to 180/110, was observed. The electromyographic firing of the external urethral sphincter was dyssynergic and hyperreflexic. The heart rate, which was initially 56, dropped to 37 per minute. The PR interval increased to 0.26 seconds. (see text).

SUMMARY

It is well known that following the state of spinal shock, bladder distention and vesical hyperactivity result in hyperactivity and dysfunction of the autonomic nervous system. There follows a vaso-constriction response resulting in compensatory redistribution of blood within the vascular bed in areas above the level of the cord transection. In instances of autonomic dysreflexia, which occur in high thoracic or carvical lesions, that is, above the sympathetic splanchnic outflow, the vasodilator responses remain insufficient to compensate for the sharp rise in blood pressure. This study describes those changes which occur at the time of reflex voiding and produce symptoms in individuals with cervical or high thoracic lesions with upper motor neuron (supranuclear/automatic) bladder. This phenomenon may be termed *"subclinical autonomic dyrefelexia"* and can in some particularly sensitive individuals result in potentially severe cardiovascular complications.

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Rancho . . .

Five full-time attending neurosurgeons, three resident supervisors, and 15 residents in the Department of Neurosurgery at the LAC-USC Medical Center are assigned to the Emergency Department. One staff member, one resident supervisor, and three residents are in the hospital available for emergency call on a 24-hours per day basis. One designated staff member provides continuous coverage for the intensive care unit.

The Neurosurgical Intensive Care Unit (NICU) has an eight-bed capacity with an additional two beds available for emergency admissions. A Kinetic Treatment Bed is also located in the intensive care unit. The nursing station is centrally located so all beds can be visually monitored. In addition to arterial lines, EKG machines and monitors, a computer-linked blood gas machine provides results in less than 30 minutes. Neurosurgical ICU staffing also includes one Registered Nurse to two patients, a Registered Nurse liaison, and an Inhalation Therapist, two Physical Therapists and administrative staff. Consultants are an Orthopedic Surgeon, Physiatrist, Anesthesiologist, a general surgeon, Urological Surgeon and a Radiologist. Neuroradiological Service is available at all times.

A 35-bed neurosurgical ward is located on the same floor as the NICU. Two neurosurgically equipped electric operating rooms with myelogram equipment and angiography facilities are also located on that floor. One quadrant of the 35-bed ward is normally set aside for acute spinal cord injured patients. Three emergency operating rooms for the hospital are available 24-hours a day.

REHABILITATION

Rancho Los Amigos Hospital is uniquely capable of providing comprehensive rehabilitative care for severely disabled patients of all ages, for whom the necessary total services within one setting are unavailable elsewhere in the community. Therapy areas, clinics, diagnostic laboratories and surgeries have been constructed for the highly specialized care of patients with complex diseases and injuries, as well as with the residual disabilities associated with these disorders.

The primary criterion for acceptance in any of the hospital's programs is that the patient is considered to have a potential for recovery or improvement with appropriate treatment.

Traditional hospital organization has been superseded by categorical grouping of patients in treatment units, according to their primary problem. Rancho has pioneered and now successfully employs the multidisciplinary team approach in the total rehabilitative management of individuals with severe disabilities. Members of the teams are knowledgeable not only in their respective disciplines but in the specific categorical problems treated on their respective services.

On the hospital grounds, over 200 buildings are maintained for patient care and supportive services. The physical facilities are constructed to allow patients' maximal independence of movement from one area to another as part of the rehabilitation process. Most buildings utilized by patients, for example, are one-story structures, equipped with electric-eye door openers and sheltered access between buildings. Ward rooms on each categorical service are spacious, and open onto a patio area which patients may use during their non-treatment hours. A new laboratory building was occupied in September 1979. In 1980, an 18,000 square foot addition to the clinic building will open with 20 new surgical nursing beds, a 12-bed ICU and 3 new operating rooms.

Rancho is affiliated with the University of Southern California Medical, Dental, Pharmacy, and allied health schools. USC's Schools of Occupational Therapy and Physical Therapy are located entirely on the grounds of the Rancho Los Amigos Hospital. Prosthetics and orthotics facilities are also located at the hospital — both programs provide patient service as well as training.

The SCI Rehabilitation Program at Rancho Los Amigos Hospital consists of four units, encompassing a total of 103 beds:

- Adult Intensive Rehabilitation (70 beds)
- SCI Readmit (25 beds)
- SCI Medical Intensive Care (3 beds)
- Pediatric SCI Unit (5 beds)

Adult Intensive Rehabilitation

When a patient is admitted for rehabilitation, that individual is assigned to a treatment team which works with that person throughout the entire hospitalization period. Each team consists of the Chief Physician, Orthopedic Fellow, Resident Physician, Liaison Nurse, Nursing Team Leader, Registered Physical Therapist, Occupational Therapist, Social Worker, Psychologist, Speech Pathologist, Recreational Therapist, and Dietitian. Other disciplines may be added as needed.

Each Team Member evaluates the patient's abilities, limitations, support systems, prior life style, and potential discharge plans. The Team Members then meet to assemble the data collected, discuss their findings and outline a rehabilitation program based on the individual patient's assets, liabilities and needs. The Rehabilitation Team then meets with the patient, the family (and/or significant others) to discuss the proposed rehabilitation program. From the time of admission, members of the patient's support system are encouraged to participate in the program. Participation of the supportive persons in the rehabilitation program has a two-fold advantage: First, it allows time for adjustment to the disability. Second, it provides an opportunity for the family members to receive instruction in the care of the patient.

The Liaison Nurse attends all patient conferences during the rehabilitation program to become acquainted with the individual patient, his needs and support group, and acts as coordinator among all disciplines to ensure effective preparation of patient and family for discharge to the community.

A variety of services are available from the Team throughout the patient's hospitalization. A pre-vocational counselor is assigned to each unit to evaluate interest, ability, education, and past work experience of the patient. A counselor from the California State Department of Vocational Rehabilitation, assigned to the service, helps the patient establish educational and vocational goals, provides information regarding the availability of training and/or sources of further education when a goal has been established, and assists with job placement.

The *Neuromuscular Engineering Service* meets periodically with Spinal Injury Service personnel to discuss and evaluate problems experienced in the delivery of health care. They obtain equipment, if it is commercially available, and construct adaptive devices. Provisions for such services have been especially useful in rehabilitating the high quadriplegic by providing the patients with some control over their environment. The engineers work with the Orthotic Department to create adaptive devices as well as to modify splints, braces, and other assistive equipment.

The Neuromuscular Engineering Department, in conjunction with the Spinal Injury Service, has also developed a model home. It was constructed so the living area, kitchen, bedroom, study, and bathroom are accessible to wheelchairs. The home is used to facilitate teaching. For example, all bathroom fixtures are movable so when a patient goes home on a pass he can measure his bathroom and bring the layout back to the Physical Therapist. Then the bathroom in the model home can be rearranged to conform to that in the patient's home. This tends to facilitate transfer teaching. In addition, it provides a valuable frame of reference for patients, their families and the Team in planning and making home modifications prior to the patient's discharge.

After discharge from the hospital, patients are initially followed in the Spinal Cord Injury Clinic. Their first visit is usually one month post-discharge. At this time, they are seen for evaluation by the same treatment team they had while hospitalized. Although followed on a routine basis, as their needs indicate, subsequent appointments are made at three-, six-, and twelve-months post-discharge.

After the initial post-discharge year, outpatient care is assumed by the Spinal Cord Injury Continuity of Care Clinic. This Clinic is managed by three nurse practitioners, with extensive training in spinal cord injury. Although clinic care is provided as needed, the major function of the Clinic is preventive medicine. Patients are given a very thorough physical examination annually. Particular attention is paid to problems common to spinal cord injured patients.

Both of the Spinal Cord Injury Clinics are primary clinics that refer to secondary clinics such as the Dental or Urology Clinics. Because of this, the Spinal Cord Injury Clinics' staff are aware of all of each patient's problems.

SCI Readmission Unit

During the course of the rehabilitation program at Rancho, spinal cord injured patients are taught the danger of pressure necrosis and learn how to prevent it. Unfortunately, a number of patients have pre-injury psycho-social personality disorders and are prone to self-destructive activities, such as heavy drug and alcohol abuse, after they leave Rancho. This segment of the patient population appears most prone to develop pressure sores, infected joints and contractures.

Because of the special needs of these patients, a program was designed to emphasize behavior modification along with the appropriate medical and surgical attention to their pressure sores and orthopedic problems. The program provides a multi-disciplinary approach that utilizes the services of a Psychiatric Social Worker, a Psychologist, Nursing Staff, Orthopedic Staff and Plastic Surgery Staff. A Psychiatrist is available for consultation.

The program is divided into three phases, each phase allowing more patient privileges and calling for more responsibility on the part of the patient. On entering the program, the patient signs a treatment contract which outlines the rules for participation in the program. During his stay in the program, the patient is given an opportunity to learn how to avoid the negative and self-destructive behavior that resulted in his spinal cord injury complication. While this is taking place, the patient is treated by the Orthopedic and Plastic Surgery Services as required.

SCI Medical Intensive Care

The idea of combining an intensive care unit and rehabilitation practices at RLAH evolved when patients with spinal cord injuries were admitted either directly from another hospital, (if they had medical problems requiring constant monitoring) or were referred to the ICU from the rehabilitation wards within RLAH when medical complications developed.

In the 12-bed Medical ICU, three beds are designated for spinal cord injured patients who require assisted ventilation, or other problems requiring constant monitoring. During a patient's stay in the ICU, the SCI Allied Health Team initiates or continues active rehabilitation service as conditions warrant.

Pediatric SCI Unit

Because of the unique challenge confronting pediatric patients (under 18 years of age) with spinal injury, a rehabilitation unit separate from adult patients is provided. In addition, these patients are followed in the Pediatric Outpatient Clinic until the age of 18.

On admission, patients undergo a complete evaluation and a treatment program is developed by all members of the Team, as well as the Pediatric Staff. Since most patients are under the age of 10, they and their families usually require more extensive instruction and education in making plans for returning the child to the home, community and school.

Home visits are made by members of the Team whenever necessary to facilitate the return of the patient to the home. School visits are made when appropriate. The children attend a school

program, operated by the Downey Unified School District, while hospitalized. At the time of discharge, every effort is made to return the child to a regular school setting. Some who are respirator-dependent are in regular classrooms, with an attendant to help with their physical needs.

The Pediatric Spinal Cord Injury Clinic provides close supervision and coordinated care after discharge from the hospital. Patients are seen at least every six months, or more often, as needed. A complete review is done annually including physical examination, occupational therapy and physical therapy evaluations, and liaison nursing evaluation of any problems. Equipment needs are reviewed and re-ordered as the children grow. Assistive and adaptive devices for school and general use in the home are maintained.

SUMMARY

The Southern California Regional Spinal Injury System — through the combined efforts of RLAH and LAC-USC Medical Center — provides total and complete multidisciplinary care for the spinal cord injured of all ages plus lifetime follow-up support. This multidisciplinary system approach to the care and rehabilitation of the spinal cord injured is the essence of team work in its truest sense.

ACKNOWLEDGEMENT

The historical research into the backgrounds of the two hospitals by Dr. Helen Martin and Ms. Bernice Kellar, and the photographic support of Steve Sampley and his staff is gratefully acknowledged.

A Symposium, "Adjustment to Spinal Cord Injury: A Cross-Sectional Study," will be held at the AMERICAN PSYCHOLOGICAL ASSOCIATION, 88th Annual Convention, September 1980, in Montreal, Canada. Wayne A. Gordon, PhD (Assistant Clinical Professor of Rehabilitation Medicine, Institute of Rehabilitation Medicine, New York University Medical Center, New York, New York) will serve as the Symposium Chairman. Abstracts of the four papers scheduled for presentation at this Symposium are presented herein.

METHODOLOGICAL ASPECTS OF LONGITUDINAL AND CROSS-SECTIONAL SCI RESEARCH

Wayne R. Dexter, PhD, Project Director and Lynn Krause, MA, Research Assistant, SCI Adjustment Project, Good Samaritan Hospital, Phoenix, Arizona; Gary T. Athelstan, PhD, Professor and Head of Counseling and Carolyn Herron, MA, Research Specialist, Department of Physical Medicine and Rehabilitation, University of Minnesota, Minneapolis, Minnesota.

The methodology adopted for the SCI psychological, social, and vocational (PSV) studies, funded by the National Institute of Handicapped Research (NIHR), is described for research now in progress in six of the 14 Regional SCI Systems. These collaborative studies were initiated approximately two years ago to expand our understanding of PSV factors relative to the medical and rehabilitation outcomes of the spinal cord injured.

PSV data are collected using psychometric tests, questionnaires and a structured interview that assess personality and intellectual traits, social functioning, and environmental characteristics. This information is correlated with other medical and functional data being collected concurrently by the Regional SCI Systems.

The cross-sectional phase of this research involves testing spinal injured persons one through five-years post-injury. In this phase, the Multiple Affective Adjective Check List (MAACL) provides measures of anxiety, depression, and hostility; work-related values are measured by the Minnesota Importance Questionnaire (MIQ); and the Human Service Scale (HSS) measures the degree to which basic needs are fulfilled, including physiological, self-esteem and other related social factors.

The longitudinal sample includes approximately 350 new spinal cord injured individuals. Initial testing is completed during the period of intensive rehabilitation prior to discharge. Follow-up testing is conducted on an annual basis over a period of four years.

The test instruments used in the longitudinal research phase consist of the Wechsler Adult Intelligence Scale, Minnesota Multiphasic Personality Inventory, MIQ, MAACL, Strong-Campbell Interest Inventory, Rotter I-E Scale, and the Activity Pattern Indicators from the Rehabilitation Indicators Project. Data from both phases of research are being analyzed to determine how PSV variables change over time and how these changes are related to the medical and rehabilitation outcomes of the spinal cord injured.

STATUS OF SPINAL CORD INJURED INDIVIDUALS ONE TO FIVE-YEARS POST-INJURY

Donald D. Thompson, EdD, Professor of Psychology, Mary Baldwin College, Staunton, Virginia; Dan Mayclin, PhD, Clinical Psychologist, Santa Clara Valley Medical Center, San Jose, California; Stefan J. Harasymiw, PhD, Assistant Professor, Department of Rehabilitation Medicine, Northwestern University Medical School, Chicago, Illinois; Wayne A. Gordon, PhD, Assistant Clinical Professor of Rehabilitation Medicine, Institute of Rehabilitation Medicine, New York University Medical Center, New York, New York.

During the past six years, data has been collected for approximately 5,000 spinal cord injured people by the 14 Regional Spinal Cord Injury Centers. This represents 33 percent of all spinal cord injuries in the United States in that time period. Six of the SCI Systems have participated in a cross-sectional study of psycho-social and vocational characteristics of 540 individuals one to five years post-injury. This sample represents over 10 percent of the SCI cases involved in the national SCI data collection effort. This is the first time that psycho-social and vocational data has been systematically and uniformly collected on a national sample of spinal cord injured individuals. Examination of the demographic characteristics of this sample indicated that this group is representative of the larger national SCI data base in terms of disability, marital status, age, sex, vocational status, and other related factors. Almost one-third of the sample is married, 10 percent is unemployed, and less than one

percent is institutionalized. The majority are single, working and living with others. These data will be used to describe:

- How both paraplegics and quadriplegics differ in their make-up and outcome status (e.g., vocational, marital, living arrangements).
- The ways in which patterns of outcome are influenced by time since onset-of-injury (one to five-years post-injury).

NORMATIVE COMPARISONS AND DYNAMIC ASPECTS OF THE SCI POPULATION

Stefan J. Harasymiw, PhD, Assistant Professor, Department of Rehabilitation Medicine, Northwestern University Medical School, Chicago, Illinois; Carolyn Herron, MA, Research Specialist, and Gary T. Athelstan, PhD, Professor and Head of Counseling, Department of Physical Medicine and Rehabilitation, University of Minnesota, Minneapolis, Minnesota; Donald D. Thompson, EdD, Professor of Psychology, Mary Baldwin College, Staunton, Virginia; Dan Mayclin, PhD, Clinical Psychologist, Santa Clara Valley Medical Center, San Jose, California; Wayne A. Gordon, PhD, Assistant Clinical Professor of Rehabilitation Medicine, Institute of Rehabilitation Medicine, New York University Medical Center, New York, New York; Wayne R. Dexter, PhD, Psychologist, Department of Behavioral Sciences, Good Samaritan Hospital, Phoenix, Arizona.

This paper is concerned with the comparison of psychometric data obtained from spinal cord injured persons who were one to five years post-injury. The test instruments administered were the Human Service Scale (HSS), the Multiple Affect Adjective Check List (MAACL), and the Minnesota Importance Questionnaire (MIQ). The HSS assesses need satisfaction using the framework of Maslow's hierarchy of basic human needs. The specific sub-scales are: Physiological, Emotional Security, Economic Security, Family, Social, Economic Self-Esteem, Vocational Self-Actualization, and an Overall score. Initial analyses show that the female overall need satisfaction is different from the male. The MAACL measures affect in the areas of anxiety, depression, and hostility. Data indicated that hostility scores were lower with persons two to four years post-injury than with persons one-year post-injury. Depression scores tended to increase with each year post-injury. The MIQ reflects the importance of 21 job-related need dimensions, such as ability utilization, activity, compensation, independence, responsibility, security, and working conditions. Preliminary analysis on the SCI sample show similar scores across the various cross-sectional year-samples, but differences between males and females.

In addition to the above intra-sample comparisons, the SCI population scores are examined in relation to existing norms for the various test instruments. Some of these comparisons involve looking at norms available for various other disability groups. It is hoped that presenting these norms for a representative SCI population will enable rehabilitation professionals to more accurately interpret test results on their clients.

THE RELATIONSHIP BETWEEN MEDICAL AND PSYCHO-SOCIAL DATA IN SCI INDIVIDUALS

Wayne A. Gordon, PhD, Assistant Clinical Professor of Rehabilitation Medicine, Biddy Sherman, BA, Psychology Assistant, and Laurie Lehman, MS, Psychology Assistant, Institute of Rehabilitation Medicine, New York University Medical Center, New York, New York; Stefan J. Harasymiw, PhD, Assistant Professor, Department of Rehabilitation Medicine, Northwestern University Medical School, Chicago, Illinois; Susan Bellile, MSW, Project Monitor, and Debra Behrman, BS, Data Collector, Rehabilitation Services Evaluation Unit, Rehabilitation Institute of Chicago, Chicago, Illinois.

Comprehensive examination of the interrelationship of physical, psycho-social, medical factors and outcome is relatively new in medical rehabilitation. The rehabilitation and post-discharge adjustment process is complex, requiring an interdisciplinary data array from which to draw inferences. Models which could show specific relationships between rehabilitation outcome concepts such as ego strength, self-concept, locus of control, vocational self-actualization, social integration, and other factors associated with outcome such as post-injury coping, response to medical treatment, and staging are only slowly beginning to emerge.

The aim of the present research study is to examine systematically the adjustment process of the spinal cord injured patients from time of injury through reintegration into the social environments. More specifically, the study attempts to identify and define specific demographic, medical and psycho-social treatment parameters that are associated with successful rehabilitation and then identify both

stages and patterns of psycho-social adjustment.

The interrelationship between medical complications, such as pressure sores and urinary tract infections, and scores on psychological tests will be examined herein. Preliminary data analysis indicates that lower scores on the Human Service Scale (HSS) are correlated with pressure sore development. Thus, individuals who developed pressure sores prior to discharge from the rehabilitative hospital have significantly lower HSS scores one to four years post-injury compared with those not having pressure sores. These findings are consistent on subscale scores dealing with vocational self-actualization, economic self-esteem, social scale, and the emotional security scale. Whether the medical-psycho-social links are casual requires further data analysis.

Caring Community . . .

CONCLUSION

In this paper, we have explained some of the descriptors of "Caring Communities," and given examples seen primarily in rural settings. The "Caring Community" can greatly influence the client's quality of life and his continuing adjustment. Rather than perpetuating the stereotype of the non-productive, dependent, disabled person, the community can assist the client in becoming a contributing citizen, thereby, benefitting both.

This discussion is intended to serve as something more than a checklist of features to be evaluated in a community. Most research has focused on characteristics of the individual patient and on interactions occurring within the hospital setting. Post-institutional follow-up analysis has been relatively slighted. We hope that this discussion provides a stimulus for further empirical study, especially of comparisons between urban and rural communities. Ultimately, the goal of these investigations should be to identify practical interventions which can be implemented in communities to provide greater awareness of the needs of spinal cord injured persons, increased responsiveness to those needs and acceptance of those individuals in the community as contributing citizens.

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number of respirator-dependent patients. Initially, it had been difficult to get general hospitals to admit polio patients. Gradually, the problem became that of getting them out. Respirator patients were being maintained in many hospitals—one or two here, two or three there—at tremendous expense, with little hope for the future.

As a partial approach to the problem, the National Foundation established Regional Poliomyelitis Respiratory Centers. Rancho Los Amigos became one of the first in 1944. The hospital developed a categorical approach to the treatment of the problems associated with severe polio cases that were respirator dependent. The categorical hospital differs from the traditional hospital in delivery of services in that the system providing patient care is based on the disability being treated rather than the traditional medical specialty delivery system.

STATUS OF NATIONAL DATA BANK
(as of April 8, 1980)

	ENTRIES TO-DATE	
INJURY YEAR (FORM I)		
1973	233	
1974	431	
1975	632	
1976	726	
1977	873	
1978	888	
1979	506	
1980	1	4280
FOLLOW-UP YEAR (FORM II)		
Year 1	2745	
Year 2	2120	
Year 3	1512	
Year 4	918	
Year 5	466	
Year 6	171	
Year 7	15	7,947

With the advent of the Salk and Sabin vaccine, the nightmare of polio epidemics ended in the United States. But, some of the lessons learned from this experience are still around. Out of the poliomyelitis respiratory treatment program came the concept of "categorical" management of catastrophic long-term illnesses and disabilities. Spinal cord injury, with its complex medical and social complications, was a logical candidate for the "categorical" approach.

Rancho continued development of a Spinal Cord Injury Service into the decade of the 60's. In 1966, it was awarded a grant from the Social and Rehabilitation Services of HEW to demonstrate a Regional Program of Spinal Cord Injury Care.

Yes, the "new kid" on the block has been around for a long time. We look forward to a fruitful association with the Rancho Los Amigos Hospital—Los Angeles County—University of Southern California Medical Center branch of the family. We also recall with appreciation the names of but a few of those that contributed to the "Rancho Tradition"—Hazel Adkins, John Affeldt, MD, Lois Barber, Clarence Dail, Elwin Edberg, Eugene Ericksen, Alice Garrett, "Bert" Keite, Vernon Nickel, "Jackie" Perry, "Robby" Robbins, Roy Snelsen, Shannon Stauffer, Elaine Wilcox, and "Dottie" Wilson. These individuals and many others have made the name "Rancho" synonymous with categorical rehabilitation.

. . . John S. Young, MD
Director
National Spinal Cord Injury
Data Research Center

Affiliated SCI Systems

University of Alabama SCI System
Univ. of Alabama in Birmingham
Birmingham, Alabama

Southwest Regional System for
Treatment of Spinal Injury
Good Samaritan Hospital —
St. Joseph's Hospital
Phoenix, Arizona

Northern California Regional SI System
Santa Clara Valley Medical Center
San Jose, California

Southern California Regional SI System
Rancho Los Amigos Hospital
Downey, California

Rocky Mountain Regional SCI System
Craig Hospital
Englewood, Colorado

So. Florida Regional SCI System
University of Miami
School of Medicine
Miami, Florida

Midwest Regional SCI Care System
Northwestern Memorial Hospital
Rehabilitation Institute of Chicago
Northwestern University
McGaw Medical Center
Chicago, Illinois

New England Regional SCI System
of University Hospital, 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
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Philadelphia, Pennsylvania

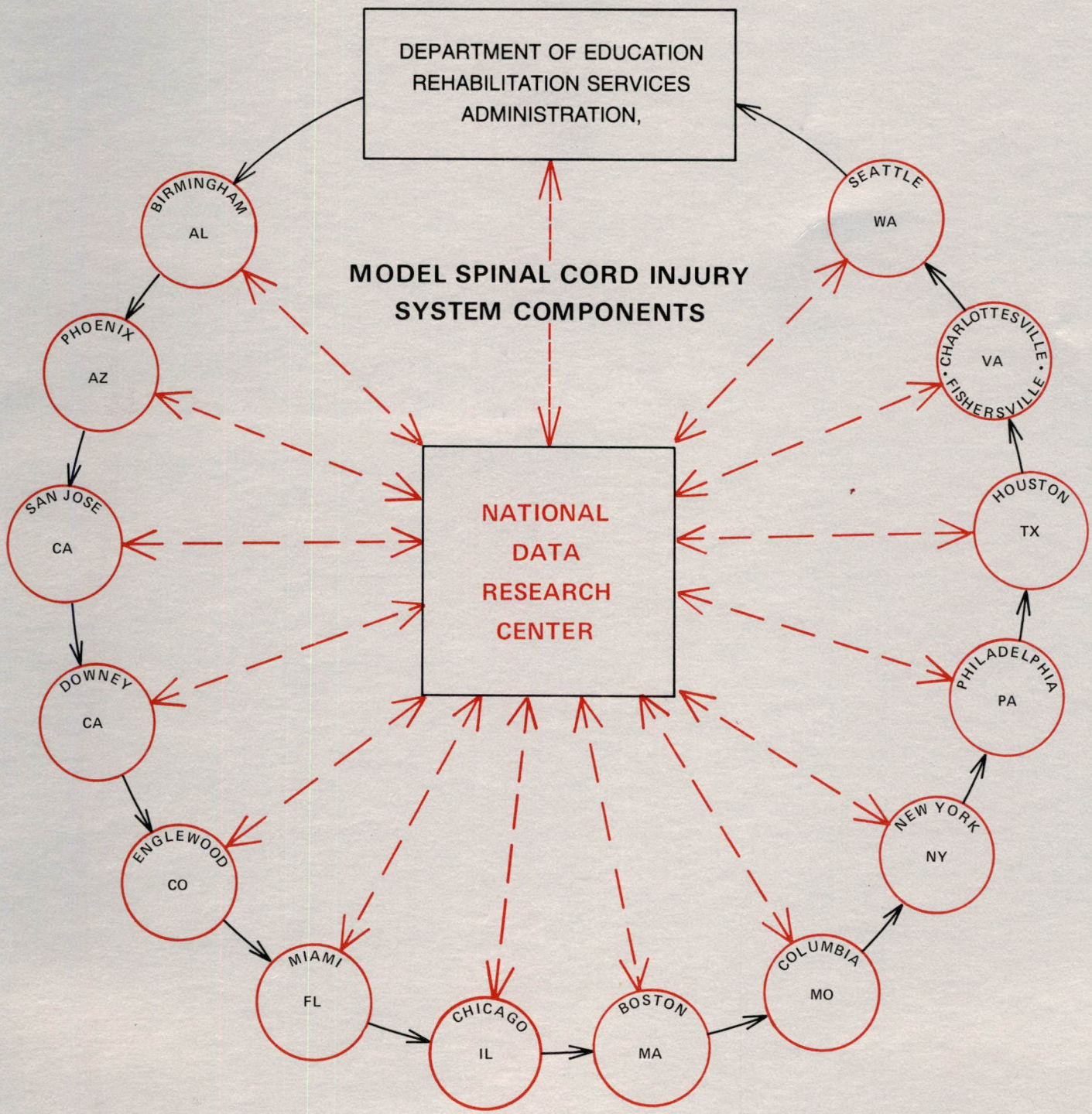
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The Institute for Rehabilitation and Research
Houston, Texas

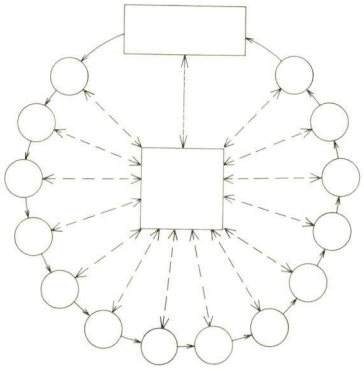
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SCI DIGEST

Volume Two
Issue Two
Summer 1980





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 U.S. Department of Education, Rehabilitation Services Administration. Each circle represents an individual Regional SCI System with the appropriate State abbreviation within the circle showing the location of each.*

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FROM THE DATA BANK . . .

SCI SPORTS INJURIES: PREVENTION



John S. Young, MD

The article, "Spinal Cord Injuries in Organized Sports." by Dr. Kenneth S. Clarke (see page 9) is an excellent example of pragmatic utilization of statistical information. Dr. Clarke—a Consultant to NSCIDRC in Sports' Medicine—is currently Dean of the College of Applied Life Studies, University of Illinois at Urbana—Champaign. Prior to his present appointment, he was Professor and Chairman of Health Education at Pennsylvania State University and Chairman of the National Collegiate Athletic Association's Committee on Competitive Safe Guards and Medical Aspects of Sports.

Dr. Clarke was instrumental in the development of the National Athletic Injury/Illness Reporting System (NAIRS) which is the source for much of the information included in his article.

The NAIRS Program, established in 1976, involved member Institutions represented by the National Federation of State High School Associations, the National Junior College Athletic Association, the National Collegiate Athletic Association, the National Association for Intercollegiate Athletics and the California Junior-College Athletic Association. This program, thus, gives access to essentially all United States' school and college sports programs. *(continued on page 45)*

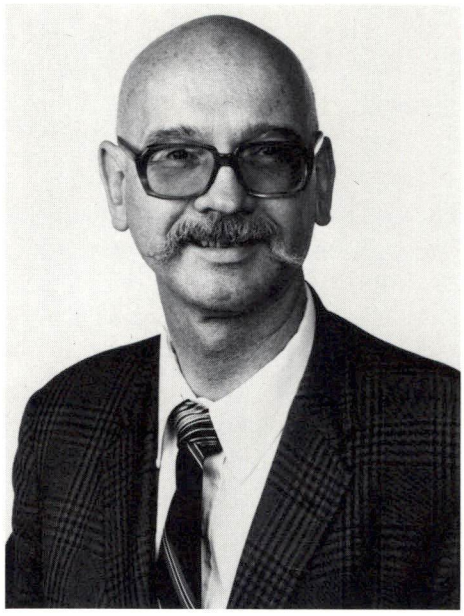
DR. JOHN S. YOUNG AWARDED SILVER MEDAL BY IMSOP

John S. Young, MD, Director, National Spinal Cord Injury Data Research Center (NSCIDRC), Good Samaritan Hospital, Phoenix, Arizona, received the Silver Medal of the International Medical Society of Paraplegia (IMSOP) in July at the Society's Annual Scientific Meeting in Beekbergen, The Netherlands. Dr. Young is the sixth person to receive the Silver Medal since the Society was founded in 1963. The Silver Medal is awarded to an IMSOP member who has made an outstanding contribution to the care of the spinal cord injured. The International Medical Society represents 850 members around the world with 230 residing in the United States. Dr. Young is a member of the IMSOP Governing Council and has served as its U.S. Corresponding Secretary for a number of years.

LAMINECTOMY

Richard D. Hamilton,* MD
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No attempt has been made in this paper to exhaustively document all that has been written about laminectomy. Instead an effort was made to cite the opinions of authors in standard textbooks and recent American journals available to most American neurosurgeons. The author's personal conclusions are presented at the end of each section throughout the paper.



Richard D. Hamilton, MD

The term "laminectomy" in various articles has differing connotations. The laminectomy may range from simple removal of the posterior arch to removal of the posterior arch opening of the dura, dentate section, myelotomy and/or needle aspiration. The comments in this paper as applied to laminectomy also apply to anterior spine decompressions (corpectomy).

HISTORY

Both David Yashon[1] and James W. Markham[2] have given excellent descriptions of the history of operative intervention in spinal cord injuries. An Egyptian manuscript written 40 centures ago described cervical dislocation with paralysis of upper and lower extremities and urinary incontinence as an ailment that could not be treated. As early as 1549, Ambroise Pare was operating for depressed splinters of bone and fragments impinging on the spinal cord. The earliest laminectomy for trauma recorded in the United States was by Alban Smith in 1828, in which Smith removed the spinous processes and depressed lamina. By 1905, Harvey Cushing described indications and contraindications for laminectomy, which led to the widespread use of laminectomy for trauma. Following World War II, Sir Ludwig Guttmann led the fight for the re-appraisal of the merits of laminectomy, which continued until his recent death.

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LAMINECTOMY VERSUS CORPECTOMY

With the beginning of the twentieth century neurosurgery, posterior laminectomy for decompression became the accepted decompressive procedure. In recent years, however, it has been shown that anterior decompression of the cord by corpectomy in the cervical, thoracic and lumbar region is a technically feasible procedure. This has spawned a new controversy between posterior and anterior decompression. Doppman and Girton[3], in monkey experiments, noted that "acute anterior epidural masses larger than four millimeters in diameter could not be adequately decompressed via the posterior approach." In lesions larger than four millimeters, he established that the monkeys remained paraplegic when laminectomy failed to relieve either the anterior spinal artery or posterior spinal vein obstruction induced by the anterior mass. Inasmuch as the human spinal canal and spinal cord are larger than the monkey's, the four-millimeter figure cannot be directly used for the human being. In this author's personal opinion, decompression should be from the anterior approach with anterior masses impinging upon the spinal cord, and by the posterior approach when posterior masses are impinging the spinal cord.

INDICATIONS FOR LAMINECTOMY AND/OR CORPECTOMY

Nothing that vaguely resembles unanimity of opinion exists in regards to the indications and contraindications for laminectomy. Very few of these opinions are based on good statistical evidence and a prospective controlled study that meets all modern scientific criteria has yet to be produced. Northfield[4] states that "Laminectomy, to 'decompress' the swollen contused segments of cord has been entirely discredited." Guttmann[5] states that "Laminectomy is still the most widely debated and most controversial subject among the surgical procedures advocated for the immediate, early, as well as late, treatment of spinal injuries."

Yashon[1] states, "there may be legitimate differences of opinion between respected and reputable physicians concerning the optimal therapy, as well as the most appropriate time to intervene. A dogmatic treatment regime is not possible in a spinal injury patient . . . . It should be stressed that there are no absolute criteria for either operative or nonoperative treatment . . . . both points of view are strongly advocated by respected champions of various form of treatment. It is a fact that no statistically significant study has been carried out, and indeed it might be impossible to do so under present circumstances."

Bedbrook[6] noted that a review of the literature showed many divergent opinions on the use and disuse of surgery, from those who always advised surgery, to those who never or very rarely advise it. Bedbrook states "(Laminectomy) as an early method of treatment for patients with lumbodorsal fractures and fracture-dislocations can now be considered a relic of the past . . . and can lead to further damage by interference with its (spinal cord's) blood supply." On the other hand, Schneider[7] lists nine indications for early spine operations after trauma, eight of which involve laminectomy.

A question posed by many authors is not only whether laminectomy is efficacious in decreasing neurological deficit, but also whether or not it can be injurious to the patient. Guttmann[5] notes "Indiscriminate exploratory and decompressive laminectomy as routine immediate management of fractures and fracture-dislocations is condemned because of the great risks, in particular in incomplete lesions, of transforming these into complete ones." Lucas and Ducker[8] note a seven percent risk of further loss of motor function in patients undergoing decompressive laminectomy. Of interest is the recent report by Anderson et al[9], in non-spinal injured cats that laminectomy caused a significant decline in spinal cord blood flow at the 15-minute and 1-hour determinations after laminectomy, but with return to normal blood flow on the third determination (24 hours post-laminectomy). The dura was not opened. They speculate the reduced blood flow was the result of temperature induced vasoconstriction.

Other worries about laminectomy include kyphoscoliosis in children as a result of laminectomy. However, the incidence of kyphoscoliosis in spinal injured children is high with or without laminectomies. Heiden et al[10] notes the increased incidence of pulmonary complications when anterior cervical fusion or a laminectomy is performed within the first week after injury. Guttmann[5] intensively felt that laminectomy helped to promote the development of spinal deformities.

PROGRESSIVE NEUROLOGICAL DEFECT

Progressive neurological defect is an area of more unanimity of opinion than any other with regard to indications for surgery. Schneider[7], Northfield[4] and Yashon feel that laminectomy is clearly indicated in such conditions. Braakman and Penning[11] agree that laminectomy is indicated in this situation if efforts have been made at reduction and the myelogram remains abnormal. The major disagreement comes from Guttmann[5] who states, "There is no hurry of immediate exploration and the longer one observes such a state by thorough and frequent neurological control, the less often will a surgical exploration be necessary." In this author's opinion, laminectomy is indicated as an emergency procedure for the incomplete patient who becomes complete, and the patient who is neurologically negative and then becomes either incomplete or is incomplete at a time after injury, if there is a partial or total block shown by myelography.

PENETRATING WOUNDS

A wide divergence of opinion exists between military surgeons and civilian neurosurgeons with regard to penetrating wounds. The various neurosurgeons who cared for Korean War casualities and participated in the writing of the neurosurgical history of the Korean War[12] felt that laminectomy was indicated (but not necessarily for decompression). It was felt that laminectomy was indicated for debridement of the wound, removal of foreign bodies within the spinal canal, and "water tight" closure of the dura to prevent extradural infection, if it occurred, from spreading to the intradural space. Heiden[10], in regard to U.S. civilians with penetrating gunshot wounds of the cervical spine, noted "The authors concluded that the full indication for routine surgical intervention appears to be progressive neurological deficits." Yashon[1] gave his guidelines as, "In general, patients with complete lesions seen after 24 hours will not be operated on unless there is gross contamination. Patients seen within 12 hours will have laminectomy and be considered for cooling." He further noted, "Significant intraspinal foreign bodies will be removed." Guttmann[5] stated that his indications for operations were:

- Removal of the retained foreign body, such as broken off tip of the weapon, after careful preparation of the patient.
- Treatment of CSF leakage which did not cease within three or four days.

In this author's opinion, all penetrating wounds of the spinal canal should be explored with adequate debridement, removal of intraspinal metallic and bony fragments, and a "water tight" dural closure. This author disagrees with Guttmann's[5] concept of operating for a CSF fistula only if it persists more than three or four days. Immediate operation is indicated. This author also disagrees with the various neurosurgeons who feel that one of the considerations in operating upon penetrating wounds is the inspection of the cord from which a neuro-anatomic estimate of damage might be made. In this author's opinion, very poor correlation exists between the gross appearance of the spinal cord at the time of laminectomy and the future neurological deficits that the patient will have—except in those cases of total severence of the spinal cord.

CAUDA EQUINA AND OTHER ROOTS

The cauda equina has considerably greater ability to recover after trauma than does the spinal cord. In animal studies, it has been noted that in the cauda equina, maximal compressive forces

for as long as five hours with initial complete sensory and motor paralysis were compatible with full functional return. Furthermore, with an incomplete sensory-motor deficit, restoration of function was observed in animals in which compression was maintained for as long as one week. Meirowsky[12] went further and stated that, "Laminectomy performed as late as five years after the initial trauma resulted in return of function of individual roots which had been compressed by bony fragments." Schneider[7] noted that in some instances he would do decompression of important cervical roots.

In this author's opinion, laminectomy is indicated for cauda equina lesions after reduction and stabilization with Harrington Rods if the post-reduction myelogram indicates a posterior block. If the block is anterior, a corpectomy and anterior bone grafting rather than a laminectomy are indicated. Also decompression of an important cervical root should be considered in those patients with asymmetric cervical levels and confirmation of impingement on the appropriate cervical root by myelography and/or computerized tomography of the spine.

SPINAL CANAL BLOCK

This covers those instances of a block on either myelography or Queckenstedt test. Yashon[1] states that evidence of an extradural block in conjunction with an incomplete progressive neurological lesion are indications for surgery without delay. He quotes other neurosurgeons who feel that myelography or spinal manometric examination are of virtually no practical value in making a judgement concerning operative intervention. Yashon's personal preference is not to use the spinal manometrics or myelography in determining indications for surgery. Rossier[13], in speaking of gas myelography, stated that in the presence of "spinal cord compression, it seems mandatory to alleviate this additional external insult as soon as possible, since delay may prove intolerable to the already ischemic nervous tissue." Schneider[7] felt that a block on the spinal manometrics examination might influence his decision with regard to surgery if the block was complete. Northfield[4] felt surgery was indicated in cases of partial cord lesions and either bony fragments or retropulsed discs within the spinal canal remaining after reduction. Braakmen[11] states, "CSF block in itself forms no indication for laminectomy." Guttmann[5] did not feel that block was an indication for surgery.

This author feels that in the acute state that early reduction is more important than open operation in unblocking the spinal canal. Certainly, in the cauda equina, if a block remains after either conservative or operative decompression, decompressive laminectomy or corpectomy is indicated. In the area of the spinal cord, this author does not operate on patients with complete lesions and block of the subarachnoid space. In incomplete lesions with block, laminectomy or corpectomy is not carried out by this author. However, this is an area where the author has vacillated in the past and may well continue to do so in the future.

PARTIAL INJURIES

Guttmann[5] feels that the presence of a partial lesion is not an indication for surgery. Schneider[7] feels that the central cord syndrome is not an indication for surgery, but may be in the anterior spinal cord syndrome "Since a surgically significant lesion causing spinal cord compression is not distinguishable from a lesion considered non-surgical, these patients (anterior spinal cord syndrome) should have exploratory laminectomy, or at least myelography. A herniated disc is the most common offender." Evaluating this concept, Heiden et al[10] studied operated and unoperated patients with cervical anterior spinal syndrome and noted no difference in the outcome of the two groups. Unfortunately, information on the myelography in these two groups was not available.

Lucas and Ducker[8] noted, contrary to the opinion of Schneider, that "The patients classified as central cord syndrome may receive some benefit with laminectomy and the optimal time would be after the first several days . . . . it is probably best in the early management of these patients to

maintain a conservative posture unless there is definite evidence of bony or soft tissue compression and a deteriorating neurological examination." Lucas and Ducker appear to be the first authors to report statistically significant improvement as a result of laminectomy in partial lesions of any type. In this author's opinion, partial lesions do not benefit from early laminectomy and/or corpectomy unless the lesions be in the cauda equina or the lesion is progressive.

PSYCHOLOGICAL

Schneider[7] states that "Under coercion the author has explored a very few patients from the psychological point of view." Yashon[1] states, "Although we cannot prove that this (laminectomy and fusion) has greater benefit than no treatment at all, as advocated by Guttmann and others, it does assure the patient that everything that could be done during the acute stage is done." This author's opinion is that a patient should not be subjected to surgery merely to indicate that "everything has been done" in situations where it has not been shown that laminectomy is more effective than non-laminectomy, and indeed may authors feel that laminectomy may be detrimental to the patient's future neurological status.

CORD HYPOTHERMIA

Cord hypothermia requires a laminectomy in preparation for hypothermic lavage of the spinal cord. In experimental animals, this seemed to work well, however, its efficacy in human cases is severely questioned. At the present time, a multi-hospital study is being carried out in the United States using this treatment. This author prefers to wait until this study is completed before making a decision on the use of hypothermia. For the present, hypothermia is not being utilized.

CONCLUSION

Laminectomy and corpectomy remain controversial. It is unfortunate that, after all these years and all the laminectomies that have been performed, no good scientific studies meeting all scientific criteria as to the value and danger of laminectomy have been made. The work by Ducker and Lucas is a beginning which will hopefully some day settle this very volatile issue. One can find support in the literature and from the experience of excellent clinicians to substantiate either a surgical or non-surgical approach to acute spinal injury. Unfortunately this professional difference of opinion is sometimes converted into malpractice judgements when the only truth agreed upon is that the scientific information for the best patient outcome has yet to be objectively determined.

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SPINAL CORD INJURIES IN ORGANIZED SPORTS*

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Experiences in sport are meant to be a series of transient events. Memories may persist, but a win must be followed by meeting another challenger; a defeat is followed by another opportunity to be a winner. It is when the outcomes tend to take on a posture of permanency that the sport and the athlete suffer. To *have* to win every time, or to be a constant loser, are equally deleterious to the spirit of athletic competition—rules and policies abound in an attempt to promote equal opportunity and to curb abuses.

The same is true for athletic injuries. Outcomes of this nature are part of sport experiences, and they too receive considerable attention in an attempt to keep them transient as well as infrequent byproducts of athletic competition. Of priority, in this regard, are the athletic injuries that are predominantly associated with permanency: those that can result in neurotrauma—i.e., injuries to the head, neck, and face. The purpose of this article is to characterize, with available epidemiological data, the current picture of spinal cord injuries in athletics.

EPIDEMIOLOGY

Trauma is a disease, and epidemiology is concerned with studying the distribution of a disease within a population and its environment. Its methods are to follow frequencies and patterns of distribution in the search for causative agents (determinants). The goal is to remove or negate the influence of an alleged determinant and then observe the extent to which that disease is thereby prevented.

While addressing itself to cause and effect, the epidemiological model must deal with associations. A documented association between a hypothesized determinant (e.g., defectively designed helmet) and a particular type of injury (e.g., cervical neurotrauma) does not constitute proof of cause and effect. A stable lessening of the problem after removing the alleged agent would be strong confirmation of that hypothesis. But, a more powerful argument, using epidemiological data, is that of "disconfirmation." If, for example, a particular helmet is alleged to be, by defective design, the cause of cervical neurotrauma, a strong association between the use of that helmet and such injuries *must* be found or the cause-effect relationship is disconfirmed.

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* This article was adapted from material prepared for publication in the book, ATHLETIC INJURIES TO THE HEAD, NECK and FACE. Joseph S. Torg, MD, Editor, Philadelphia, Lea & Febiger (to be published).

+ Professor of Health and Safety Education; Dean, College of Applied Life Studies; University of Illinois, Champaign, Illinois.

To evaluate injury patterns (frequencies and associations), comparisons must be made. Whether the comparison be year-to-year, sport-to-sport, squad-to-squad, level-to-level, or male-to-female, both a reasonable rationale and sufficient data are necessary to permit a fair comparison. The epidemiological model thereby requires a merging of population data, exposure data, injury data, and injury scenario data to that end.

First, the population at-risk must be characterized. Then, the opportunity for that population to contract the disease (i.e., the opportunity for them to receive an injury) must be reasonably established. The experiences recorded as injuries can then be put in perspective with the use of "rates".

For example, fifty athletes attending five practices constitute 250 athlete-exposures (i.e., the opportunity for 250 injuries). If two were injured, the rate would be 2 cases per 250 athlete-exposures or 80/10,000 athlete-exposures. A rate of 2 cases per 50 athletes or 4/100 athletes would also be a legitimate expression if variation in length of season between squads is not substantial.

Additional types of rates may be expressed to assist conceptualization of a problem. The number of athletes per case (e.g., one football fatality for every 340,000 athletes) gives a probability figure which can be used for describing and comparing an individual's risk in that sport. The number of squads per case gives a probability figure helpful to a sponsoring institution's understanding of its relative risk of experiencing an injury.

Injury scenario data (related circumstances) are necessary to examine the associations of the many factors of potential preventative or injurious influence, individually and, in combination, with the injuries experienced.

The bottom line in epidemiology is knowing the incidence of the problem (frequency of new cases within a population). Without a baseline, the effectiveness of preventive measures cannot be evaluated. But, without identifying patterns within the aggregate of injuries as well, one has no beacon for foreseeing the relative merits of suggested preventive measures.

FATALITIES

Football is the only high school/college sport with mortality incidence data over the years (since 1931).[1] The first additional epidemiological treatment of that data was in mid-1960.[2] In that exercise, the football fatality rate of 1964 was compared on an actuarial basis to vital statistics information for that age group. Not only did football not increase the participant's risk of death from all causes, but riding in an auto had a nine times higher fatality rate, on a man-hour exposure basis, than playing football. Ten years later, not only did the actuarial picture for football remain benign, but the football-auto fatality ratio was 1:27.[3]

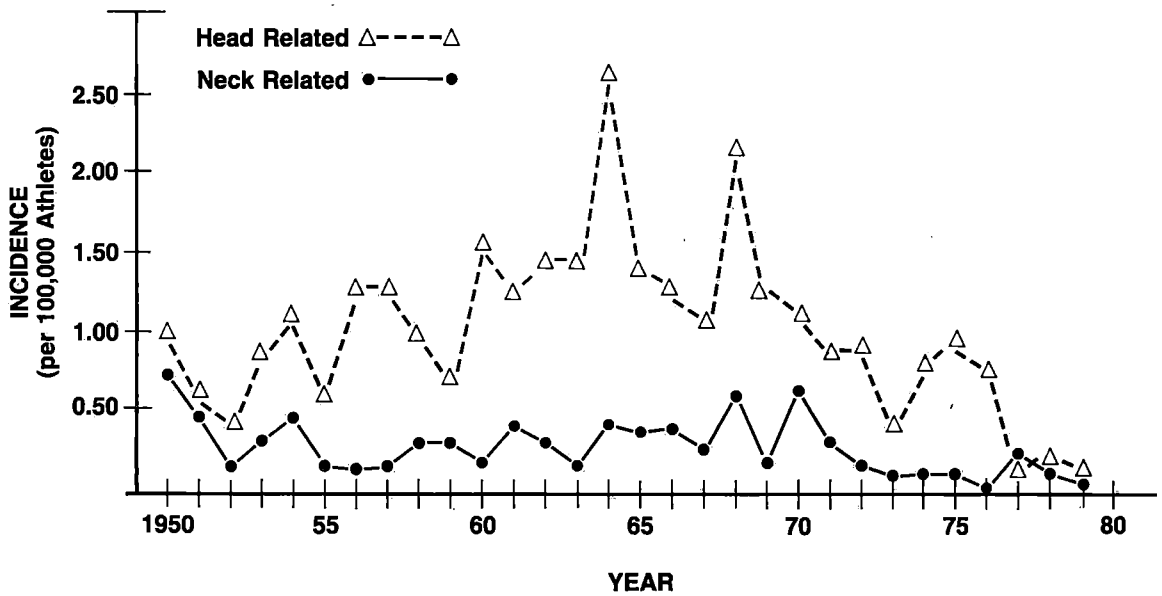
NECK-RELATED FATALITIES

From the 1950s through the present, approximately nine of every ten football deaths from traumatic injury involved the head or neck; however, by separating head from neck, different frequency patterns (Figure 1*) are observed. Essentially, deaths from cervical cord injury have been infrequent yet persistent over the years.

The development of the modern helmet and facemask in the 1950s and 60s, however, was associated both with changes in blocking and tackling techniques (i.e., bringing the helmeted head into the contact more purposefully) and a substantial increase in deaths from head injuries. That trend in head-related fatalities not only was reversed by the early 1970s but, after 1976, dropped down to the "infrequent yet persistent" level of neck injuries. This was undoubtedly influenced by several determinants.

* Data presented in Figure 1 were prepared by the author from that found in the Annual AFCA Football Report.

Figure 1. HEAD AND NECK FATALITIES: HIGH SCHOOL AND COLLEGE FOOTBALL* 1950–79 SEASONS



* Adapted by Clarke from the AFCA ANNUAL FOOTBALL FATALITY REPORTS

In the late 1960s, the National Operating Committee for Standards in Athletic Equipment (NOCSAE) was formed for the initial purpose of developing standards against which all football helmet models were to be successfully tested before being marketed. By 1974, these standards were being utilized by all manufacturers, even though the wearing of helmets that had passed NOCSAE standards was not mandatory until 1978 at the college level and 1980 in high schools.

Also, by the late 1960s, an anti-spearing education campaign was intensified by the American Medical Association, National Federation of State High School Association (NFSHSA), National Collegiate Athletic Association (NCAA), and others.[4] Then, in January 1976, high school rules, college rules, and coaching ethics were formally adopted that prohibited tackling/blocking techniques in which the helmeted head received the brunt of the initial impact.

The primary reason for these prohibitions was the vulnerability of the athlete's cervical spine when striking the opponent with the top or crown of the helmet (e.g., NFSHSA Rule 9-3-1 and NCAA Rule 9-1-2-n). However, the phrasings and intent were also to preclude the deliberate use (and the teaching) of facemask and brow contact (e.g., NFSHSA Rule 9-3-2-k and NCAA Rule 9-1-2-l). Making contact in that latter position, however, was not considered a cause of cerebral or cervical spinal cord injury *per se.*

The contention was that by leading with the head, one cannot always ensure the desired football position of "heads up, neck bulled" at the moment of contact, and improper execution could put the athlete's head and/or neck in a most vulnerable position. By not leading with the head, improper execution would not be as potentially devasting. The rule was thereby adopted. In 1978, an organized approach to the coach's education of the athlete concerning the latter's shared responsibility in this regard was initiated by the NCAA.[5]

NONFATAL CATASTROPHIC INJURIES

Equivalent trend line data were not available for nonfatal catastrophic injuries until recently. In 1976, Clarke surveyed retrospectively (1973-75) such experiences among the varsity programs of all high schools and colleges in the nation and found Gymnastics to have the highest average annual injury rate of all the sports (Table 1).[6] Of the others, only Football and Wrestling showed an annual persistence of such injuries. Of these three sports, only Gymnastics and Football presented describable patterns.

Table 1. AVERAGE ANNUAL RATE OF SPINAL CORD INJURY IN HIGH SCHOOL/COLLEGE—SPONSORED SPORTS. 1973–1975*

	SPINAL CORD INJURIES		
SPORTING EVENT	ATHLETES PER CASE	PROGRAMS PER CASE	AVER. ANNUAL RATE Per 100,000 Athletes
Gymnastics			
Men	7,000	281	14.3
Women	24,000	1,113	4.2
Football	28,000	403	3.6
Wrestling	62,000	1,781	1.6
Baseball	177,000	6,254	0.6
Basketball			
Men	793,000	23,024	0.1

* Adapted from Clarke, *J. Safety Res.*, 9, 143, 1977

GYMNASTICS

The patterns of injury among all the events within the label *"Gymnastics"* revealed the predominant association of the trampoline (as a training device), but not to the exclusion of other gymnastic apparatus (Table 2). Also, the vast majority of these injuries occurred when the athlete came down incorrectly *on* the apparatus. This finding, coupled with a subsequent observation that invariably the stricken trampolinist had been attempting a somersault, resulted in the adoption of national consensus guidelines in 1978 for the controlled use of the trampoline and mini-tramp.[7,8]

Another offshoot of this survey was the advent of a National Registry of Gymnastic Catastrophic Injuries in July 1978 patterned after the AFCA Football Fatality Report.[9] In the first year

Table 2. ADJUSTED PROPORTION OF PERMANENT SPINAL CORD INJURIES BY GYMNASTIC EVENT IN HIGH SCHOOL/COLLEGE -SPONSORED PROGRAMS. 1973–1975*

	SPINAL CORD INJURIES			
	MEN		WOMEN	
GYMNASTIC EVENT	NUMBER OF CASES	PERCENT OF TOTAL CASES	NUMBER OF CASES	PERCENT OF TOTAL CASES
	(N)	(%)	(N)	(%)
Trampoline	3	33	5	71
Minitramp	1	11	0	—
Horizontal Bars	2	22	—	—
Rings	1	11	—	—
Free Exercise	2	22	1	14
Unevens	—	—	1	14
Not specified	4		2	
TOTAL CASES	13		9	

* Adapted from Clarke, *J. Safety Res.*, 9, 145, 1977

(July 1978 through June 1979), seven gymnastic injuries, resulting in cervical neurotrauma were reported across the nation: six quadriplegics and one death. Only the trampoline and mini-tramp were implicated and none occurred under conditions of organized sport—only one occurred within the context of physical education (to an instructor). The skill level and circumstances of each injury are as follows:*

EVENT	PERSON	CIRCUMSTANCES
Trampoline	Skilled Teenager	Practice, Gymnastics Club
Trampoline	Young Boy	Backyard Recreation
Trampoline	Skilled Young Adult	Backyard Game of "Horse"
Trampoline	Advanced Beginner Teen	Military Base Recreation
Trampoline	College Asst. Instructor	P.E. Class Demonstration
Mini-tramp	College Cheerleader	Warmup for Football Game
Mini-tramp	High School Gymnast	Practice for Pep Rally

This completes only the first year of a continuing effort, but catastrophic injuries in Gymnastics appears to have lessened substantially since the mid-1970.

FOOTBALL

In Fall 1975, while Clarke was preparing the retrospective survey of spinal cord injuries in school sports and physical education, Torg was establishing a National Football Head and Neck Injury Registry patterned after the clinical case finding method used by Schneider in 1973.[10,11] Initially, he solicited retrospective documentation of catastrophic cases experienced during the 1971 through 1975 seasons to have a five-year period comparable to that of Schneider (1959–63). Subsequently, Torg maintained the Registry as a continuous surveillance system, operating cooperatively with the American Football Coaches Association System but extending beyond fatalities.

When Torg's findings for catastrophic injury patterns in Football during 1971–75 are compared with those of Clarke for 1973–75, the proportions of quadriplegic cases associated with the act of tackling in the two periods are as follows:

DATA SOURCE	PROPORTION OF QUADRIPLEGICS	
	High School	College
Torg** (1971–75)	72%	78%
Clarke+ (1973–75)	83%	83%

The high degree of comparability gives credibility to the principal injury scenario of a defensive back coming up to make an open field tackle. A similar comparison of the proportion of quadriplegics associated with a selected position is given in Table 3 (page 14).

In Table 4, the differing patterns of cervical neurotrauma in high school/college Football are shown for the 1959–63 and the 1971–75 eras. Serious cervical cord injuries had increased substantially, but their predominantly nonfatal nature precluded detection of this trend via the Annual Fatality Report.

* Adapted from Clarke et al., *First Annual Gymnastics Catastrophic Injury Report,* U. S. Gymnastics Safety Association, 1980.

** Adapted from Torg, *JAMA,* 241, 1479, 1975.

+ Adapted from Clarke, *J. Safety Res,* 9, 145, 1977.

Table 3. PROPORTION OF QUADRIPLEGIC CASES IN HIGH SCHOOL/COLLEGE FOOTBALL ASSOCIATED WITH SELECTED PLAYING POSITIONS.

PLAYING POSITION	PROPORTION OF QUADRIPLEGIC CASES (1971–75)* (%)	(1973–1975)+ (%)
Defensive Back		
High School	52	50
College	73	67
Linebacker		
High School	10	29
College	—	—

* Adapted from Torg, *JAMA*, 241, 1479, 1979.
+ Adapted from Clarke, *J. Safety Res.*, 9, 145, 1977.

Table 4. COMPARISON OF PERMANENT CERVICAL SPINAL CORD INJURIES NATIONALLY IN HIGH SCHOOL/COLLEGE FOOTBALL.

DATA SOURCE	SPINAL CORD INJURIES REPORTED NATIONALLY			
	TOTAL CASES REPORTED	HIGH SCHOOL & COLLEGE CASES	AVERAGE ANNUAL INCIDENCE	FATAL CASES
	(N)	(N)	(Per 100,000 athletes)	(%)
Schneider* (1959–1963)	38	30 (est)	0.9 (est)	42
Torg+ (1971–1975)	99	95	1.5	8

* Adapted from Schneider, *Clin Neuro*, 12, 234-235, 1965
+ Adapted from Torg, *JAMA*, 241, 1478, 1979

The Torg vs Schneider data, at first glance, appeared to indicate that a tradeoff was occurring—the evolution of the modern helmet was accompanied by increased cervical cord injuries. To some, this meant that the modern helmet was literally causing these injuries (back of helmet forcibly impinging on the spine) instead of, or in addition to, prompting the well protected athlete "to stick his head/neck in places where he never used to." However, the distinct drop in the frequency of cervical cord injuries since 1976 (Table 5) disconfirms the alleged active involvement of helmets as causative agents.

Table 5. NUMBER OF NONFATAL PERMANENT NEUROTRAUMA CASES REPORTED NATIONALLY IN HIGH SCHOOL/COLLEGE FOOTBALL, 1975 THROUGH 1978*

YEAR REPORTED	PERMANENT NEUROTRAUMA CASES			
	CEREBRAL		CERVICAL CORD	
	HIGH SCHOOL	COLLEGE	HIGH SCHOOL	COLLEGE
	(NUMBER OF CASES REPORTED)			
1975	6	2	23	4
1976	3	1	25	7
1977	3	1	10	2
1978	5	1	11	0

* Adapted from presentation of Torg at the Annual Meeting of the American orthopaedic Society for Sports Medicine, June 1979.

The premise for the 1976 rule changes was that helmets can neither cause nor prevent the serious neck injury; it is a matter of blocking/tackling technique. The epidemiological data in hand are consistent with that contention. This did not mean that coaches were necessarily teaching improper technique prior to 1976, but that improper execution of certain techniques constituted a very serious hazard.

Calculated as rates,* the incidence of permanent cervical cord injury, non-fatal and fatal combined, was one per 100,000 athletes in 1977 and 1978, the same as that during the time of the Schneider study. As was the case for fatalities alone, the trends in relative frequency of all cervical neurotrauma, which by 1978 had returned to that of 1960, do not support an indictment of the facemask or helmet as a causative agent.

POTENTIALLY CATASTROPHIC INJURIES

It is neither sufficient to rationalize away severe injuries because they are infrequent nor to confine one's attentions only to the severe injury. The National Athletic Injury/Illness Reporting Systems (NAIRS) has been following athletic injuries in various sports since 1975, including the potentially serious head and neck injuries.[12]

FOOTBALL HELMETS

NAIRS data were examined for the association of particular helmets with major cervical spine fractures, in view of the contention of some that the back edge of certain helmets can produce a "karate chop" injury to the spine, producing quadriplegia.[13] The data are presented in Table 6 in terms of manufacturer only because shell configuration did not vary within brand. Rates were expressed per 100,000 athlete-exposures because of the rarity of these occurrences. The criterion of *Major* injury was used (i.e., greater than three weeks absence from athletic participation) to preclude inclusion of vertebral fractures that do not threaten the integrity of the spinal cord.

Table 6. AVERAGE ANNUAL RATE (CASES PER 100,000 ATHLETE-EXPOSURES) OF MAJOR CERVICAL SPINE FRACTURES BY BRAND OF HELMET IN HIGH SCHOOL/COLLEGE FOOTBALL. 1975–77*

	MAJOR CERVICAL SPINE FRACTURE		
BRAND OF HELMET	NUMBER OF CASES	AVER. ANNUAL RATE**	HELMET USE (%)
1	0	0	8.6
2	4	0.5	60.7
3	0	0	6.6
4	1	1.4	5.9
5	1	2.4	3.5
6	0	0	2.9
7	0	0	10.2
ALL HELMETS	6	0.5	100.0

* Adapted from Clarke, *Med. Sci. Sport,* 11, 144, 1979
** Cases/100,000 Athlete-Exposures.

Only six major vertebral injuries were experienced over the three seasons (from over a million athlete-exposures); only one of these resulted in neurological deficit (quadriplegia from a hyperflexion injury). The vast number of helmet contacts in a season (giving ample opportunity for such a defective design to operate), the infrequency of this type of injury, and the proportionate distribution of these injuries over the helmets being worn, epidemiologically disconfirm the allegation that the helmet is a viable mechanism of cervical injury.

* Calculated by the author from the injury data provided by Schneider and Torg and from the population data found within AFCA Annual Football Fatality Report.

BRACHIAL PLEXUS ("BURNER") INJURIES

With the rule changes in 1976 requiring a return to a form of shoulder blocking and tackling technique, concern over an increase in brachial plexus injuries from these changes was frequently expressed. The potential for such had been acknowledged by those encouraging the 1976 changes, but the tradeoff between *"burners"* and quadriplegia presented no argument.

Table 7. RATE (CASES PER 100 ATHLETES) OF BRACHIAL PLEXUS INJURIES IN COLLEGIATE FOOTBALL ACCOMPANIED BY PROPORTION OF SUCH INJURIES ASSOCIATED WITH THE ACT OF TACKLING.*

YEAR REPORTED	BRACHIAL PLEXUS INJURIES (ASSOCIATED WITH ACT OF TACKLING)			
	REPORTABLE CASES		SIGNIFICANT CASES	
	(RATE)	(%)	(RATE)	(%)
1975	2.2	45	0.5	31
1976	2.2	47	.5	40
1977	2.2	43	.5	47
1978	2.4	38	.7	27

* From the National Athlete Injury/Illness Reporting System, The Pennsylvania State University, 1979

Interestingly, NAIRS data reveal no shift in frequency of reportable or significant brachial plexus injuries after 1976 (Table 7). The slight rise in 1978 is at present of no significance (i.e., is well within the range of normal variation), but will be re-examined to learn whether a trend may be in the making.

Table 7 also permits examination of this concern by the proportion of such injuries coming from the act of tackling (the principal activity associated with this injury). A steady increase in this-association is seen among significant brachial plexus injuries from 1975 to 1977 (31 to 47 percent); however, in 1978 this trend was clearly reversed. It is plausible to assume that the new coaching techniques for tackling have evolved into improved methods and/or that better neck conditioning practices had been implemented. Again, the patterns associated with this injury will continue to be followed by NAIRS in subsequent seasons.

COMMENTS AND CONCLUSIONS

Catastrophic neurotrauma in organized sport is infrequent yet consistently associated with Gymnastics, Football, and Wrestling. Other active sports such as Baseball and Basketball experience such injuries periodically but not with the persistence which would permit an epidemiological analysis.

From the catastrophic data at hand, fatal and non-fatal, the recent definitive measures adopted by those sharing responsibility for school and college sport have been followed by a substantial lessening of the problems that had been identified:

- The recent clarification of guidelines for the controlled use of the trampoline and mini-tramp in school and college programs has been followed (to date) with a near void of catastrophic injuries from these activities.
- The decision to promulgate uniform testing standards for football helmets in the late 1960's was accompanied by a downward trend of serious cerebral trauma.
- The decision in 1976 to outlaw, by rules and ethics, the use of the helmeted head in Football as the initial point of contact in blocking and tackling was followed by another downward trend in serious cerebral injuries and by a substantial drop in cervical spinal cord injuries. Moreover, these latter changes were successful without causing (to date) the anticipated increase in another neurological type of injury—that to the brachial plexus.

In addition, analysis of recent epidemiological data disconfirmed the possibility that a particular brand of helmet was a determinant of the onset of spinal injuries in Football. Further, the continuous presence of the facemask during the period of evaluation was not associated with any trends that

would support its involvement as a determinant of serious neck injuries. This is corroborated by Torg's clinical analysis of each case reported to his Registry and by Shield's series of Football-related quadriplegia cases in which 15 of the 16 stemmed from hyperflexion injuries.[14]

In Football, as in Gymnastics, and probably in Wrestling and the other sports where reliable data are lacking, the problem of cervical neurotrauma is principally a matter of player technique and conditioning (conditioning should be considered part of "technique"). Education of coaches, athletes, and officials concerning the catastrophic hazards of improper techniques should continue to be emphasized in preventive efforts.

To date, catastrophic injury data remain available only due to voluntary peer reporting networks and only for Football and Gymnastics. Steps have been taken to tie these efforts in with the National Spinal Cord Injury Data Research Center's data reporting network. Not only would the completeness of the Football and Gymnastics Registries be enhanced (or verified), but the opportunity to discern patterns of spinal cord injuries in other sports and recreational activities would be readily available. Preventive measures could then be developed with the same potential effectiveness experienced in Football and Gymnastics.

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VOCATIONAL PLACEMENT OF THE SPINAL CORD INJURED: POTENTIAL OR PROBLEM*

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From its inception, the New York Institute of Rehabilitation Medicine has been concerned with the successful vocational rehabilitation of the severely physically disabled, especially the spinal cord injured. Even in those early years, many of the spinal cord injured returned to a positive vocational status.

Things were different then. Patients came to the Institute of Rehabilitation Medicine (IRM) months and even years post-injury with all the ramifications implied by that. Institutionalization had set in—apathy, depression, low self-esteem, and so on. The field of medical rehabilitation, in terms of both knowledge and technology, was in its infancy, making the job of medical rehabilitation, let alone vocational placement, even more difficult.

By the time the Institute became a Regional Spinal Cord Injury Center in 1973, patterns of health care delivery were beginning to change. This was facilitated in part by the new government mandate, to admit spinal cord injured patients to rehabilitation facilities as soon after injury as possible. Now patients are usually seen in the immediate post-acute stage when their medical condition has stabilized. Patients, both paraplegics and quadriplegics, move quickly through the rehabilitation process with discharge occurring much sooner than ever before. While some patients leave with vocational plans in place, unfortunately, many are not ready to make any plans for various reasons—emotional, family, economic, transportation, and others.

It was not surprising to learn that the National Spinal Cord Injury Data Research Center statistics on the successful vocational outcome of spinal injured individuals indicate that anywhere from 13–48 percent became involved in competitive employment.[1] This large variation is attributable to difficulties in comparing results of studies using different methodologies and involving samples of individuals who vary in terms of self-selection factors, such as: the amount of vocational training, the time since onset-of-injury, age, and other related factors.

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It was decided to examine the IRM data to see if a vocational pattern would emerge among a population in which recency of injury and shorter rehabilitation time-frames were becoming the norm. A survey of 114 paraplegics and 147 quadriplegics, admitted between 1974 and 1978, was undertaken. This time period was selected because 1974 was the first year of the Institute's designation as a Regional Spinal Cord Injury Center, and 1978, the last complete year of recorded data. Seventy-three of the 114 paraplegics and 110 of the 147 quadriplegics had at least one follow-up. The following variables were examined:

- Vocational status at onset.
- Vocational status at each follow-up.
- The relationship of Barthel Self-Care and Mobility Scores to vocational status.

Of the total paraplegics and quadriplegics, 90 percent were in a positive vocational status at time of onset—positive vocational status being defined as competitive employment, student, or homemaker.

At the first year follow-up, that is at the anniversary of onset-of-injury, of 46 paraplegics contacted, 44 percent were employed. The second year follow-up began to show a significant increase in positive vocational status—59 percent of those contacted were now working. In the third year, virtually no change occurred in the percentage of those working—58 percent. In the fourth year, a significant increase was noted—71 percent of these contacted were in a positive vocational status. See Table 1.

Similarly with the quadriplegics, (Table 1), at the first year follow-up, 35 percent were in a positive vocational status; by the second and third year follow-up, increases in positive vocational status appeared—48 percent in the second year and 45 percent in the third year. By the fourth year follow-up, the positive vocational status was up to 55 percent. It is interesting to note that there were relatively fewer quadriplegics than paraplegics in positive vocational outcomes than might be expected. The curve of "return to work" is similar for the two groups of individuals.

Table 1. VOCATIONAL STATUS OF PARAPLEGICS/ QUADRIPLEGICS IN FOLLOW-UP YEARS ONE THRU FOUR. (1974–1978 data)

		VOCATIONAL STATUS	
NEURO-IMPAIRMENT	FOLLOW-UP YEAR	WORKING (%)	UNEMPLOYED (%)
Paraplegics	1	44	37
	2	59	14
	3	58	19
	4	71	29
Quadriplegics	1	35	50
	2	48	40
	3	45	38
	4	55	39

While it would be expected that a non-vocational status would be prevalent in the first year, it is encouraging to find that a more active life begins to take place in the second year. And, as already noted, while there is little differential between the second and third years—by the fourth year, activity shows a considerable increase. This might suggest that there are three discrete time periods asssociated with vocational placement: one year post-injury; two to three years post-injury; and four years post-injury. Future analyses will determine what factors differentiate those individuals in each of these groups. This information might be useful not only in understanding the rehabilitation process but possibly in speeding it up as well.

In looking at some individual cases, it was found that among those who had been employed at onset, several returned to the same job with their same employer, or at least the same employer, following discharge, and have *maintained* their employment status. Certain factors seemed to be common among all of them—namely, positive support from spouse and/or family; interest of employer in employee's rehabilitation process; and the willingness of the individual to return to work when possible.

Among the patients who were students at onset-of-injury, it was found that those with a definite objective have had successful outcomes. They returned to school, graduated and became employed. For example, a law student, with a C4-5 lesion, returned to school, graduated and was hired by a law firm; a medical student with a C4 lesion returned to medical school, graduated and is now pursuing a specialty in psychiatry; an educational therapist with a C4-5 lesion entered a Master's degree program, graduated and was hired by a VA Hospital. In each of these cases, the lesion levels were high.

Having examined two variables—vocational status at onset-of-injury and vocational status at each follow-up—this leads to the third variable, the relationship of Barthel Self-Care and Mobility Scores to vocational status. The findings were a surprise, and important for all rehabilitation disciplines to keep in mind when assisting patients and their families with future vocational planning.

The National Spinal Cord Injury Data Research Center (NSCIDRC) uses a Modified Barthel Index to evaluate a spinal cord injured person's capability to perform specific daily routines and mobility, and the individual's need for assistance. The Barthel Index was developed by F. Mahoney and D. Barthel[2] and modified by C. V. Granger.[3]

The Barthel Index is divided into two sub-scales: nine items for Self-Care and six items for Mobility. Items which are thought to be more important to independence are weighted more heavily than items not considered important, e.g., ambulation versus grooming. From the NSCIDRC Data Base, the following total scores are used: A person scoring 100 on the Barthel Index is independent of assistance from others; scores of 91–99 indicate a slight dependence; scores of 61–90 indicate moderate dependence; scores of 21–60 indicate severe dependence; and scores of 0–20 indicate total dependence in self-care and mobility.

Table 2 indicates the number (N) of patients in each category (working, unemployed, retired), the mean Barthel Score for Self-Care and Mobility at discharge and first year follow-up, and the standard deviation for the scores. Most paraplegics and quadriplegics, whether working, unemployed or retired, had similar mean scores at the time of discharge as well as at their first follow-up. The combined mean scores for Self-Care and Mobility at discharge for paraplegics and quadriplegics were 77 and 48, respectively. The data clearly demonstrates the expected marked dif-

(continued on page 44)

Table 2. MEAN BARTHEL SCORES FOR PARAPLEGICS AND QUADRIPLEGICS RELATIVE TO VOCATIONAL STATUS (1974 – 1978 data)

		PARAPLEGICS			QUADRIPLEGICS		
		NO.	BARTHEL SCORE		NO.	BARTHEL SCORE	
BARTHEL SUB-SCALES	VOCATIONAL STATUS	PATIENTS (N)	MEAN (M)	STD. DEV (SD)	PATIENTS (N)	MEAN (M)	STD. DEV. (SD)
Self-Care	Working at Discharge	45	47.1	3.2	57	31.2	13.4
	First Follow-up		47.5	3.6		29.8	14.3
	Unemployed at Disch.	23	46.4	4.3	47	27.7	12.0
	First Follow-up		48.0	2.9		27.0	12.1
	Retired at Disch.	5	45.4	5.1	5	40.4	9.6
	First Follow-up		45.0	3.1		35.2	17.6
Mobility	Working at Discharge	45	31.2	8.5	57	18.9	14.9
	First Follow-up		30.3	10.8		18.3	15.0
	Unemployed at Disch.	23	29.6	10.2	47	15.3	11.8
	First Follow-up		31.0	9.3		12.8	10.6
	Retired at Disch.	5	27.2	16.1	5	34.4	14.5
	First Follow-up		27.4	11.8		34.0	17.6

COMMUNITY RELATIONS: DEVELOPING A TOTAL SYSTEM OF SCI CARE

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The development of a total system of care for spinal cord injured persons obviously requires the coordination of medical, surgical and rehabilitative care during the acute hospitalization and rehabilitation period. Physicians, nurses, therapists and other allied health professionals must work together to deliver the highest quality of care based on experience with a large number of spinal cord injured patients and knowledge of the latest technological and clinical advances in the field. Optimal care for spinal cord injured persons includes patient/family education with emphasis on the prevention of long-term complications and the importance of compliance with self-care routines.

The hospitalization and rehabilitation experience of the newly spinal cord injured patient is unquestionably a critical factor in the person's "successful" rehabilitation and adjustment to the disability. Because it is so important that a person receive optimal care as soon as possible after injury, a Spinal Cord Injury Center must also provide mechanisms for early referral and impact on the quality of emergency care in the region.

The inpatient hospitalization and rehabilitation period, although important, represents a very small percentage of time in the person's experience with disability. Indeed, Dr. Harry Hahn, Medical Director, Craig Hospital, Englewood, Colorado, observed that this period represents only about 0.1 percent of the SCI person's life span. As Dr. John Young stated in the Winter, 1980 *SCI Digest,* "The initial treatment and training of the injured person is not enough."

More often than not, the ongoing problems faced by the victim of traumatic spinal cord injury are life-long in nature. In order to provide a total system of care for the spinal cord injured, a follow-up system must be developed to assist the disabled person in dealing with ongoing and other problems after returning to the community. The follow-up system must also transcend the traditional model of medical follow-up care and include a multidisciplinary approach. Although the potential for medical complications is real, so too are complications relative to the person's psycho-social-vocational adjustment to disability and his/her functional abilities.

The involvement and interaction of a Regional SCI System with community resources is essential for the development of a total system of spinal cord injury care, particularly with the emergency care and the ongoing follow-up phases. The Regional Spinal Cord Injury System of Delaware Valley (RSCISDV) has been working with the community to develop mechanisms for communications, utilize present resources, and make available additional community and other resources for the spinal cord injured population. The model being devised by the Regional Spinal Cord Injury

* Project Coordinator

System of Delaware Valley is applicable to an urban region such as the metropolitan Philadelphia area. To incorporate this model into a rural setting or into a system that serves a larger geographical area would be difficult.

EMERGENCY CARE SYSTEM DEVELOPMENT

No organized system for the triage of acutely spinal cord injured patients exists in the State of Pennsylvania. Because of "the enormous loss of human resources . . . and the loss of individual productivity, estimated to be nearly $1.2 million of the gross national product per case," Secretary of Health, Leonard Bachman, MD, convened the Spinal Cord Injury Committee in 1976 to develop a State plan.[2]

To date, the Pennsylvania Plan for the designation of Spinal Cord Injury Centers and triage of emergency services has not been implemented. With the designation of the RSCISDV by the Rehabilitation Services Administration, U.S. Department of Health, Education and Welfare, developing a system for the triage of spinal cord injured patients within the region became a matter of vital importance.

In the City of Philadelphia, the Fire Rescue Service of the Philadelphia Fire Department is responsible for the emergency care and triage of all acutely injured persons in the community. The Philadelphia Health Management Corporation (PHMC), under the direction of David G. Faris, MD, Director, Emergency Medical Services, provides EMT-A and Paramedic training as well as serving in an advisory capacity to the Fire Rescue Service.

The Project Director and staff of the Regional Spinal Cord Injury System of Delaware Valley began working with Dr. Faris and the PHMC Staff in the education of Philadelphia medical personnel early in 1978. Cooperative efforts initially took the form of education relative to the emergency treatment of neurological injuries. After the designation of the RSCISDV, an emergency triage plan for spinal cord injured individuals became essential.

The Emergency Triage Protocol that has been developed provides an organized system for the working paramedic to:

- Identify and assess the possibility of spinal cord injury.
- Communicate with the Base Commander and the RSCISDV.
- Apply immobilization techniques.
- Recommended on-the-scene treatment.
- Transport in accordance with instructions.

SCI ASSESSMENT SCALE

In order to help paramedic personnel identify persons with possible spinal cord injuries, an assessment tool was developed. The SCI Assessment Scale is designed to be used in a manner similar to the Glascow Coma Scale, in that numerical values are given to specific easily recognized physical findings. With the SCI Assessment Scale, paramedic personnel may determine, at the scene, the probability of a spinal cord injury and, thereby, initiate appropriate treatment without delay!

The SCI Assessment Scale divides the physical findings into three modalities: Movement; Sensation; and, Spinal Pain. Each modality is then divided into three levels with corresponding numerical values, one, two and three. Normal movement, normal sensation, and the absence of spinal pain are each graded as 3, for a total score of 9. Inability to move the extremeties and the

SPINAL CORD INJURY ASSESSMENT SCALE

The SCI Scale is a tool for assessment of the ability to move extremities, the ability to sense light touch and pain, and the presence or absence of pain and tenderness over the spine. Any patient with a score of three to six should be suspected of having sustained a spinal cord injury and should be transported to a comprehensive spinal cord injury center.

MOVEMENT:	Can move arms and legs normally.	3
	Has obvious weakness in arms and/or legs.	2
	Unable to move arms and/or legs.	1
SENSATION*:	Can sense touch and pain in hands and feet.	3
	Decreased ability to sense touch or pain.	2
	Unable to sense touch or pain in hands and/or feet.	1
SPINAL PAIN:	No localized pain or tenderness over spine.	3
	Localized pain or tenderness over spine.	2
	Pain in neck or back verbalized.	1

* Test with pin to determine ability to perceive and differentiate between sharp (pain) and dull (touch).

TOTAL: 3–9

presence of spinal pain are each graded as 1, for a total score of 3. Using this scale, any patient with a total score of 3-6 should be suspected of having sustained a spinal cord injury. The patient should be treated accordingly and transported to the RSCISDV.

LINES OF COMMUNICATION

The Emergency Triage Protocol also defines lines of communication for the paramedic at the scene of the injury. When a possible spinal cord injury is identified, the EMT/Paramedic notifies his Medical Commander to obtain instructions to transport the patient to the RSCISDV. The RSCISDV is then contacted so that preparations to receive the patient can be made.

If the patient's condition is such that transportation directly to the Spinal Cord Injury Center would be life endangering, in the opinion of the EMT/Paramedic on the scene and the Medical Commander at the base hospital, the patient is transported to the nearest hospital for life support and stabilization.

The Emergency Triage Protocol with the SCI Assessment Scale have been submitted to the Philadelphia Fire Department and the City of Philadelphia for approval. Until the Protocol is approved, the Fire Rescue Service EMT/Paramedics must continue to transport all patients to the nearest hospital emergency departments. Final approval of the protocol is anticipated in the near future.

NEUROLOGICAL TRAUMA

The Philadelphia Health Management Corporation has assisted the RSCISDV in working cooperatively with the Head Injury Center at the University of Pennsylvania Hospital. By doing so, a combined protocol for neurological trauma triage has been developed which, if approved, will divide the responsibilities for at least half of the city so that all spinal injury emergencies will be taken to the RSCISDV and all severe head injury emergencies will be taken to the Head Injury Center.

RSCISDV ADMITTANCE

With approval and implementation of the Emergency Triage Protocol, it is expected that a larger percentage of patients will be admitted directly to the Regional Spinal Cord Injury System. Other efforts being made by the RSCISDV to encourage early referral include public and professional education. Awareness of the presence of a Spinal Cord Injury System in the region, combined with specific guidelines for referral of acute patients, assists the professional in the community to responsibly triage persons suspected of having spinal cord injuries.

The effectiveness of the inpatient hospitalization and rehabilitation program is maximized when patients are admitted to the Regional Spinal Cord Injury System as early as possible after the injury occurs. The System is responsible, therefore, to work with the community in order to develop the best plan for triage.

FOLLOW-UP CARE SYSTEM DEVELOPMENT

Developing a system that provides comprehensive lifetime follow-up care for persons with spinal cord injury requires the resources of more than just the Regional Spinal Cord Injury System. The large number of persons requiring medical follow-up alone can overextend even the largest SCI Staff. Comprehensive follow-up care, which must include involvement of a multidisciplinary team, is often overburdened by the demand for services.

Follow-up services required by persons with spinal cord injury may be divided into three major categories:

- Primary and secondary medical care.
- Functional and equipment reevaluation plus maintenance care.
- Ongoing psycho-social-vocation evaluation and counseling.

The disabled person often needs ongoing assistance in facing the issues of living independently in the community to which he/she returns after discharge from the hospital or rehabilitation facility. The staff of the RSCISDV can best provide this assistance as it relates to health care accessibility, vocational evaluation training and placement, equipment repair, and professional counseling.

Other assistance relative to attendant care, housing, legal rights and advocacy, transportation, and recreation may better be provided by resources in the community. The value of peer counseling to assist disabled persons to cope with the multifacet process of adjustment to disability also must not be underestimated.

In order to ensure comprehensive Follow-Up Services, the Regional Spinal Cord Injury System of Delaware Valley has devised a plan which includes the utilization of RSCISDV resources, community resources, and disabled consumer resources. Some community and System services are currently available. Other services, including consumer resources, require development.

FOLLOW-UP CLINIC

The initial step taken to provide Follow-Up services was the establishment of a multidisciplinary Follow-Up Clinic. Staffed primarily by a Physiatrist, Rehabilitation Clinical Nurse Specialist, and Social Worker, the Clinic provides the basic medical, nursing and psycho-social care needed by spinal cord injured persons after discharge from the hospital. Problems identified in the Clinic are referred to appropriate resources within the RSCISDV and/or the community.

During the first six-months of operation, the Follow-Up Clinic staff realized that the clinic model, in itself, cannot fully meet the needs of the patients. As mentioned earlier, certain aspects of assistance could best be provided by other resources.

In an effort to more adequately meet the needs of the patients, the Regional Spinal Cord Injury System Staff began working with disabled consumers in the community early in 1980. An all day meeting was held with the RSCISDV health care professionals to allow representatives of the disabled consumer groups to define and discuss issues of living independently. The meeting was the beginning of an ongoing dialogue between the consumers and the System Staff.

The working relationship has already resulted in two significant developments related to the creation of a more comprehensive follow-up program. Although difficult to measure, the System Staff professionals now have a more realistic understanding of the needs of patients after discharge. This has been evidenced in specific changes in the inpatient care program which are designed to more fully prepare patients for the realities of community living.

CENTER FOR INDEPENDENT LIVING

The System Staff assisted consumers of Disabled in Action of Pennyslvania, Inc. in the preparation of a grant proposal for the development of a Center for Independent Living in Philadelphia. The proposal has been accepted by the State of Pennyslvania but Federal approval of the State plan is still pending at this time.

A consumer-based Center for Independent Living located in Philadelphia will provide many ongoing follow-up care services for the patients of the Regional Spinal Cord Injury System of Delaware Valley. The Project Director and Staff of the RSCISDV will continue to work with the Center for Independent Living as it is deemed appropriate by the consumers.

PRIMARY CARE PHYSICIAN

A major problem identified by the Follow-Up Clinic staff during the first six months of operation, was that 42 percent of all patients were identified as having no primary care physician in the community. The reasons were varied and included:

- Unidentified family physician prior to injury.
- Inaccessible health care facilities.
- Lack of desire to initiate relationship with an unfamiliar physician.
- Dependence on System physicians and staff.

The medical staff of the RSCISDV is committed to the concept of System-based follow-up care in conjunction with community-based primary medical care. In order to establish such a model for medical follow-up, however, it is necessary to impact on the quality of the primary care that is available.

The Family Practice Department of the Jefferson Medical College has had a close working relationship with the Department of Rehabilitation Medicine for many years. Each Family Practice Resident Physician rotates through the Magee Memorial Rehabilitation Center, working with the spinal cord injured as well as with the general rehabilitation patient. As a result, many Family Physicians, currently practicing in the Delaware Valley, have some knowledge of the needs of the spinal cord injured.

The model for comprehensive medical follow-up care will include the identification of Family Physicians in the community who are both interested in the caring for SCI patients and knowledgeable about their primary care needs as well as the recognition of complications which require referral to the RSCISDV. The System Staff is working with the Family Practice Department to identify interested physicians in the community and develop a core curriculum for their continuing education relative to spinal cord injury care. The core curriculum is being developed by the System Staff with the assistance of the Family Practice Department and will be published, in part, in the 1981 edition

of Conn's CURRENT THERAPY IN PHYSIATRY. Continuing education and an ongoing dialogue between the System Staff and community physicians is essential so that lifetime care for the spinal cord injured is maintained in the community.

VOCATIONAL

After the initial hospitalization and rehabilitation period, many patients require ongoing vocational evaluation, training and job placement counseling. It is recognized that no single program can completely meet the needs of every spinal cord injured person. Although the vocational evaluation process must begin during the initial hospitalization, many resources exist within the community which offer varied programs to meet the ongoing vocational needs of these spinal cord injured individuals.

The Regional Spinal Cord Injury System of Delaware Valley has initiated a comprehensive evaluation of currently existing vocational resources in the community. Additional services are needed within the System, but maximum utilization of all currently available resources will permit the System to ensure that a comprehensive vocational program is available for the spinal cord injured population.

SUMMARY

The Executive Committee and Staff of the Regional Spinal Cord Injury System of Delaware Valley recognize that a Model System of SCI Care must ensure quality care from the time of injury through ongoing lifetime follow-up care. The System can only offer a comprehensive system of care by working with the community.

Perhaps the key to developing a "total system" is communication and cooperation. The System must communicate with community leaders and consumers relative to:

- The prevention of spinal cord injuries.
- The optimal emergency care, treatment and triage of persons with traumatic spinal cord injuries.
- The delivery of optimal inpatient services.
- The implementation of comprehensive follow-up services.

But the System must also allow the community to communicate its concerns and needs relative to the disabled population. With ongoing open communication, cooperation can be achieved and the potential for the devlopment of a system of total care may be realized.

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COMPREHENSIVE RENAL SCINTILLATION PROCEDURES FOR URINARY TRACT SCREENING IN SPINAL CORD INJURY*

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INTRODUCTION

Complications of the genitourinary system remain the leading cause of morbidity and mortality among spinal cord-injured patients and may occur regardless of the bladder management employed.[1] Although long-term surveillance of the urinary tract is necessary for detection and treatment of urological complications in spinal cord injured patients, there is no universal agreement as to methodology or timing of examinations. However, most investigators suggest that semi-annual or annual evaluation is necessary during the first years following spinal cord injury with annual or bi-annual examinations of the asymptomatic patient during later follow-up years.

Excretory urography is the almost universally used examination for rapid screening of the upper urinary tract.[2] This examination permits excellent anatomic visualization of the urinary tract although it is a relatively poor indicator of renal function.[3] Serum creatinine or creatinine clearance determinations are generally utilized for functional evaluation in conjunction with the excretory urogram (EXU).

Our favorable experience with the Comprehensive Renal Scintillation Procedure (CRSP) in other types of patients suggested that this procedure might be used as the primary screening examination in place of the excretory urogram and serum creatinine.[4,5] This radionuclide examination provides information regarding the function of the individual kidneys and the entire urinary tract. This would have a number of significant advantages particularly for the spinal cord injured patient. No bowel preparation is required for the examination, hence no interruption in the patient's bowel routine is needed.

The examination is performed in a well hydrated state so that overnight fasting and dehydration are not required. Radiation exposure during the examination is considerably lower than with conventional excretory urography. This is particularly important in patients who require frequent serial

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evaluation for urinary tract surveillance.[4] No toxic or allergic reactions have ever been recorded with ^{131}I-orthoiodohippurate, the agent utilized for Comprehensive Renal Scintillation Procedures. In contrast, the excretory urogram has many undesirable side effects including flushing, nausea and vomiting in addition to occasional severe reactions which result in a mortality rate of 1 in 40,000 to 1 in 50,000.[6]

Our experience with 468 patient evaluations where comprehensive renal scintillation procedures were performed in addition to routine urinary tract screening, including excretory urography and serum creatinine, are reported herein.

MATERIALS AND METHODS

From June 1977 to November 1979, 314 patients underwent 468 CRSP's. Seven examinations were unsatisfactory due to technical errors and were subsequently repeated. One hundred and two patients were examined on two separate occasions; 23 patients on three separate occasions; and, two patients had four separate examinations. Patients included in this study were those undergoing initial or annual evaluation at Spain Rehabilitation Center. Standard patient evaluation consisted of a brief history and physical examination, excretory urography, cystography, serum creatinine and urea nitrogen, urine culture and sensitivity, and residual urine determination.

Routine nephrotomography was employed with excretory urograms according to previously reported techniques.[7] Radiographic examinations were monitored by a Radiologist and delayed or other special films were obtained when indicated. The excretory urograms were then interpreted and graded according to degree of pyelocaliectasis or ureterectasis by a radiologist and either a Urologist or Physiatrist (Table 1). No grader was aware of the patient's identity or the grading of the other reviewers. Differences in grading were adjudicated by a third grader.

Table 1. GRADING OF EXCRETORY UROGRAMS.**

GRADE	CALYCEAL BLUNTING	URETERAL DILATATION
I	Minimal	Minimal
II	Moderate	Moderate
III	Severe	Severe
IV	*	*

* Surgically absent or non-functioning kidney

** In addition to above, more obvious defects such as cortical loss, calculi, delayed function or poor concentration were noted

Comprehensive Renal Scintillation Procedures were performed as near the time of excretory urography as feasible, usually within one month. The completed CRSP was interpreted by a Nuclear Medicine Physician and Urologist. Any disagreements were arbitrated by a third person and the majority opinion utilized for comparison. Normal limits of CRSP parameters are as follows:

NORMAL COMPREHENSIVE RENAL SCINTILLATION PROCEDURE

1. ERPF—greater than 420 ml/minute.
2. 30-35 Minute Return—greater than 66 percent
3. Percent of relative blood flow to each kidney—45-55 percent
4. Peak Counts—5 minutes or less and within one minute of opposite kidney.
5. 25-26 Minute Counts—less than ⅓ of peak counts.

A CRSP in which one or more of these parameters was outside normal limits was considered abnormal. After interpretations of EXU's and CRSP's was completed, all studies were compared and the concordance of the two examinations was determined.

COMPREHENSIVE RENAL SCINTILLATION PROCEDURES

The Comprehensive Renal Scintillation Procedure (CRSP) is a quantitative evaluation of total urinary tract function combining calculation of effective renal plasma flow (ERPF), excretory index, sequential scintigraphy, and computer analysis of the time activity curves after a single injection of ^{131}I-orthoiodohippurate (OIH). In the well hydrated adult, 150 μCi of ^{131}I-OIH per kidney is injected intravenously and the kidneys are imaged with a scintillation camera continuously for twenty-seven minutes. A bladder image is then obtained with the detector anterior to the patient, urine is collected at thirty-five minutes and another bladder image recorded. A single blood sample is drawn at forty-four minutes post-injection for ERPF determination. The injection site is routinely imaged to ensure that infiltration of the radionuclide did not occur.

ERPF

^{131}I-OIH injected in the peripheral circulation is removed from the plasma in the kidneys by both glomerular filtration and active tubular secretion and almost quantitatively excreted in the urine. This permits calculation of OIH clearance, a measure of the plasma flow to the kidneys (effective renal plasma flow or ERPF), that correlates well with classical paraaminohippurate (PAH) clearance (Figure 1).[8]

Utilizing a formula developed by Burbank and Tauxe, ERPF can be calculated by measuring residual activity in the plasma at forty-four minutes after injection.[8,9] Although error is smallest at forty-four minutes, measurement of a single plasma sample drawn between forty and fifty minutes results in an error of less than twenty-five ml/minute.[8,10] The formulas are valid for an ERPF up to 550 ml/minute with an ERPF greater than 420 ml/minute being the normal adult value.

Figure 1. CORRELATION OF ORTHOIODOHIPPURATE CLEARANCE CALCULATIONS WITH CLASSICAL PAH CLEARANCE DETERMINATION.

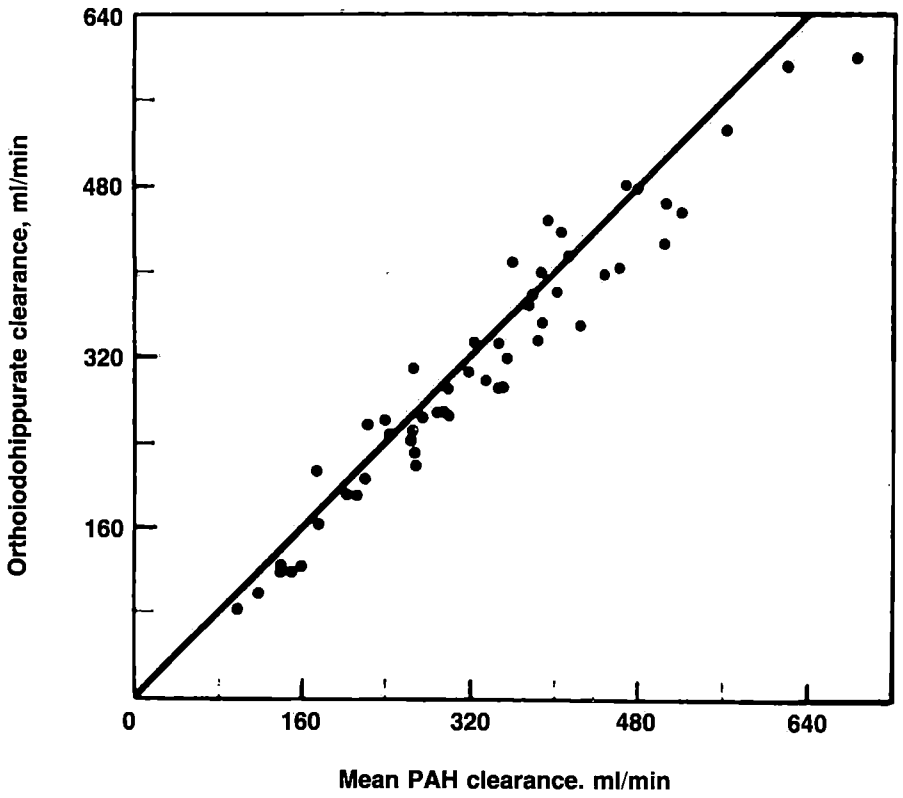
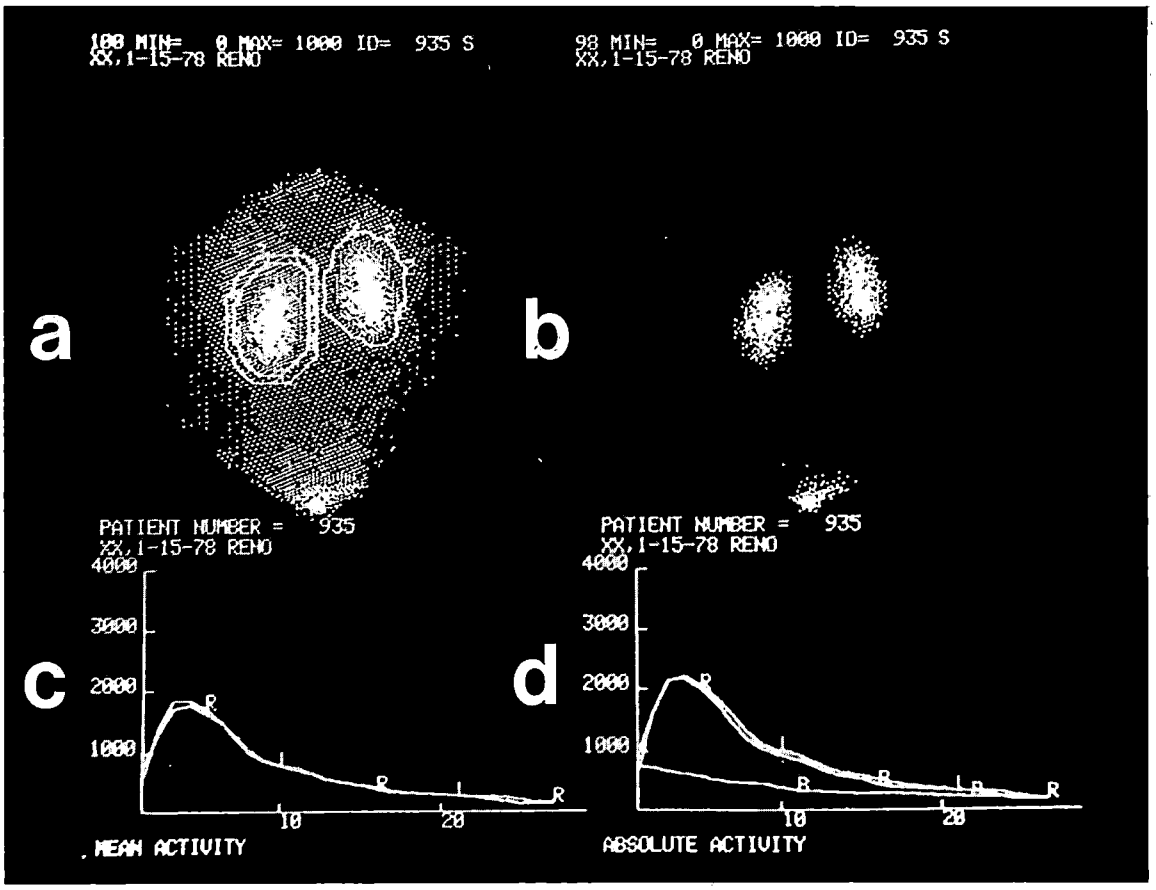


Figure 2. CUMULATIVE SCINTIGRAPHIC DATA WITH ROI's DRAWN AROUND LEFT KIDNEY BEFORE (A) AND AFTER (B) BACKGROUND SUBTRACTION.
Time-activity curves with (c) and without (d) background subtraction.



Since the amount of OIH excreted in the urine is a function of ERPF and time, it is possible to calculate the fraction of the injected dose that will be found in the urine at various time intervals after the injection. Calculation of the activity in the urine at thirty-five minutes, including residual bladder urine, should be no less than 68 percent of the injected dose in the normal subject.[11]

The excretory index (EI), a ratio of the total excreted activity (voided urine plus residual bladder urine) to the expected excretion is 1.0 ± 0.16.[5]

DIFFERENTIAL FUNCTION

The scintigraphic information is recorded during the study on computer compatible magnetic tape or directly by the computer. Scintiphotos are made for general anatomic information. After completion of the study, the data is displayed on a color television screen as a single image of the renal region. Regions of interest (ROI's) are drawn around each kidney. After background subtraction, time activity curves or renograms are generated (Figure 2). The number of counts in selected one-minute time frames is printed out by the computer (Figure 3). Differential renal function is then calculated by using the number of counts in the 1-2 minute frame and expressing them as fractional contribution of each kidney to the total number of counts. The parameters of a normal CRSP study were listed previously.

Figure 3. COMPUTER PRINTOUT OF RENOGRAPHIC DATA, PATIENT INFORMATION, AND ERPF. (Note differential function at 1 to 2 minute frame utilized for determining right and left ERPF.)

V.A. HOSPITAL
NUCLEAR MEDICINE SERVICE
BIRMINGHAM, ALABAMA

RENOGRAPHIC DATA

NAME:XX
PT NO: 935
AGE:54 SEX:M
HEIGHT(IN): 68.0 WEIGHT(LBS):165.0 SURFACE AREA(M2): 1.88
LEFT KIDNEY AREA(CM2): 66.(53.%) RIGHT KIDNEY AREA(CM2): 58.(47.%)

	LT KIDNEY		RT KIDNEY	
MIN	NT CT	%	NT CT	%
0-1	605	57	463	43
1-2	1611	51	1579	49
2-3	2157	50	2159	50
3-4	2244	51	2188	49
4-5	2157	51	2072	49
10-11	959	52	874	48
15-16	560	54	474	46
25-26	241	48	256	52

PEAK TIME LEFT: 4 MIN
PEAK TIME RIGHT: 4 MIN

URINE
SPECIFIC GRAVITY: 1.009
VOLUME(ML): 134.
*****

OIH DOSE(UCI): 300.
TOTAL ERPF(ML/MIN)@44 MIN: 551.4
RIGHT:264.5 LEFT:287.0
CORR ERPF(ML/MIN/1.73 M2): 506.3
EXPECTED EXCRETION: 77.2%
ACTUAL VOID: 66.4%
AT 33. MIN
RESIDUAL URINE(ML): 4.3
TOTAL EXCRETION: 68.6%
EXCRETORY INDEX: .89

****

IMPRESSION:

TECHNICAL ASPECTS

The CRSP requires a high degree of technical expertise and careful attention to detail. ^{131}I-OIH must be checked chromatographically for free iodide since free iodide is excreted more slowly. More than 1.5 percent free iodide gives spurious ERPF values. Dose infiltration at the injection site also affects the ERPF and fractional excretion values. If infiltration is detected on imaging the injection site, usually the study must be repeated at a later date. Timing of urine and plasma collection is very important and must be accurately recorded. Handling and counting of these specimens must likewise be done with care.

Although processing of the acquired data has been greatly simplified, the operator plays an important role in the selection of ROI's.[12] It is essential to include the entire kidney in the ROI. ROI's drawn too close to the kidney may exclude some cortex and significantly alter differential function. However, if the ROI on the right side is too large, liver activity may spuriously increase the apparent function in the right kidney. Differential function is more distorted by background oversubtraction than undersubtraction.

It is extremely important that the patient be well hydrated for the study. Dehydration does not alter ERPF but it prolongs transit time of the OIH and may result in altered differential function, delayed peak time, pelvic retention, and decreased fractional excretion. Measurement of urinary specific gravity helps to detect this condition. A urinary volume of less than 100 milliliters with a small

residual at 35 minutes should caution the interpreter not to overread the study and incorrectly diagnose obstructive uropathy or abnormal differential function.

SPINAL CORD INJURED PATIENTS

Patients, such as the spinal cord injured, who lack bladder control and mobility require some special considerations. During imaging, the position of the detector has to be changed from under the table to over the bladder and later to over the injection side. If injection is made in the lower extremity, the time required for the radionuclide to reach the kidneys is prolonged. This must be considered in selecting the zero time for generating the one-minute time frames since the second frame determines the differential function.

Accurate timing of urine collection is often difficult since most SCI patients cannot void on command. Although some patients require catheterization, voiding can usually be induced by triggering a reflex contraction or manually expressing the urine. Patients on Foley drainage may be left on continuous drainage during the study and a single bladder image obtained to measure residual activity at the completion of imaging. In patients who cannot void, or who have large residual volumes, the bladder activity can be estimated using a chart developed by counting various volumes and quantities of radiohippurate.[13]

RESULTS

Comparison of results for 468 patient evaluations, including both an excretory urogram and a comprehensive renal scintillation procedure, is summarized in Table 2. Although a number of patients had examinations performed on more than one occasion, these were considered as individual examinations for study purposes. One hundred and two studies showed normal CRSP's and normal EXU's while only 41 patients had normal CRSP's but abnormal EXU's. Three hundred and twenty-five patients had abnormal CRSP's; 149 of these had a normal EXU and 176 had an abnormal EXU. A different diagnosis was made, depending on the test utilized in a total of 190 studies.

Table 2. COMPARISON OF EXU AND CRSP

CRSP	EXU		
	NORMAL	ABNORMAL	TOTAL
Normal	102	41	143
Abnormal	149	176	325
Total	251	217	468

Among the 41 patients with normal CRSP's but abnormal EXU's, only four renal units displayed greater than minimal pyelocaliectasis or ureterectasis and two with Grade II ureterectasis. No Grade III changes were seen in patients with a normal CRSP; nor were other urographic abnormalities detected in the face of a normal CRSP.

In the 176 patients with abnormal CRSP's and abnormal EXU's, 46 renal units displayed 58 urographic abnormalities which did not correlate with the CRSP. Four Grade II changes were seen in three renal units but no Grade III or other significant urographic abnormalities were seen that were unaccompanied by alterations in the CRSP.

Of the 149 examinations with a normal EXU and abnormal CRSP, many minor abnormalities were noted which would not be expected to result in clinical intervention. There were, however, a number of significant decreases in renal function with a normal EXU. Serial evaluations will be required in those patients to determine if these functional changes precede anatomic abnormalities or occur independently. Findings in this group of patients will be addressed in future studies.

There were 935 renal units in the 468 patient evaluation. One patient had only one kidney, the other had been surgically removed. Among these 935 renal units, only 104 demonstrated radiographic abnormalities unaccompanied by changes in the CRSP (Table 3). Only eight Grade II

abnormalities were noted in seven renal units with normal CRSP, an incidence of less than one percent. More severe abnormalities on the EXU were always accompanied by abnormality on the CRSP. Pyelocaliectasis and ureterectasis were frequently seen in the same renal unit thus, accounting for the disparity in abnormalities that occurred in six patients. One patient, RF, had Grade II ureterectasis on two annual evaluations accompanied by a normal CRSP on both occasions. This urographic abnormality showed no progression in almost three years of follow-up. Another patient, VC, had a Grade II pyelocaliectasis with a normal CRSP. Review of other radiographs showed the abnormality to be stable over a three-year period. DH displayed Grade II pyelocaliectasis and ureterectasis in the same renal unit with a normal CRSP but at follow-up one year later, the urographic changes had improved to Grade I. CM had Grade II pyelocaliectasis with a normal CRSP in January 1978. Review of radiographs showed the same findings in February 1977, but in January 1980, they had reverted to Grade I changes. The remaining two patients, SJ and GB, have only had one evaluation. Each had Grade II pyelocaliectasis in a single renal unit with a normal CRSP. No patient in the entire group had an abnormal serum creatinine or urea nitrogen with a normal CRSP.

Table 3. SUMMARY OF EXU ABNORMALTIES WITHOUT CRSP CORRELATION (468 Evaluations; 935 Renal Units)

EXU ABNORMALTIES			RENAL UNITS	PERCENT OF TOTAL*
GRADE	TYPE	NO.		
		(N)		(%)
I	Pyelocalietasis	53	97	10.4
	Ureterectasis	68		
II	Pyelocalietasis	5	7	0.7
	Ureterectasis	3		
III	Pyelocalietasis	0	0	0
	Ureterectasis	0		
*935 RENAL UNITS		Total	104	11.1

DISCUSSION

Renal function status and excretory urography in spinal cord injured patients have been evaluated by other investigators,[14,15] Price and co-workers, utilizing inulin and PAH clearances, found that deterioration of renal function as determined by changes in GFR, ERPF, and TmPAH correlated with calyceal blunting on the excretory urogram and vesicoureteral reflux on the cystogram.[14] Morales et al. also studied inulin and PAH clearances in small groups of paraplegic patients.[15] They concluded that renal functional impairment, as demonstrated by inulin and PAH clearances, was always present if severe hydronephrosis (equivalent of Grade II in the current study) was accompanied by renal functional impairment in four of five patients. They also found, as we did in the current study, that functional impairment was frequently detected while the excretory urogram remained normal.

While inulin and PAH clearances remain useful research tests, difficulty in performing them has prevented them from becoming clinically useful. ^{131}I-OIH clearance studies have been shown to correlate well with PAH clearances and also with creatinine clearances.[8,11] Moreover, the Comprehensive Renal Scintillation Procedure has the advantage of being relatively easy to perform and has the capability of determining individual as well as total renal function. This permits detection of abnormalities in a single kidney when compensatory mechanisms in the opposite kidney might allow total renal function to remain in a normal range.

Clinically, serum creatinine or creatinine clearance determinations have been utilized for functional evaluation in conjunction with the excretory urogram.[16] Serum creatinine is a sensitive indicator of renal function once it becomes abnormal but is a less sensitive indicator while in the broad, normal range. This may be particularly true in spinal cord injured patients who may continue to lose muscle mass over the first few years following injury and hence maintain a stable or even lower serum creatinine in the face of deteriorating renal function.

Creatinine clearance determinations, while more accurate indicators of changes in renal function than serum creatinine, require a minimum of several hours urine collection, a task which may be particularly difficult to achieve in an outpatient setting where a number of tests and consultations are sought during the same day. Moreover, careful timing of urine collection may be difficult in the spinal cord injured population. Also, outpatients are usually dehydrated in preparation for excretory urography. Both serum creatinine and creatinine clearance determination yield only total renal function information and give no information regarding relative function in the two renal units.

Comprehensive Renal Scintillation Procedures have been utilized by other investigators for evaluation of urological abnormalities and for serial patient evaluation. Schlegel and Bakule concluded that a radionuclide study, a plain abdominal X-ray for detection of urinary calculi and urine analysis were highly accurate in detecting urinary tract abnormalities when used for screening large number of patients.[11]

Bueschen et al. and Evans et al. compared the results of renal scintillation camera studies and excretory urograms in children with a variety of urological problems and concluded that all significant upper urinary pathology was detected by the CRSP.[4,17] Evans and co-workers found the CRSP a useful evaluation for serial follow-up of children with vesicoureteral reflux and concluded that an excretory urogram need not be performed unless the CRSP is abnormal.[17]

Results of the current study in the spinal cord injured population confirms the usefulness of the CRSP as a screening examination. In this study, renal function impairment and significant obstructions or anatomic abnormalities, which do not ordinarily precipitate clinical intervention, were found in ten percent of the renal units with a normal CRSP. Only seven renal units displayed Grade II abnormalities on the EXU when the CRSP indicated a normal renal unit. Furthermore, four of the six patients in whom these changes were seen displayed stable or even improved urographic findings on serial follow-up from two to three years. Although further follow-up in this group is necessary, these results suggest that anatomic abnormalities unaccompanied by functional alterations may not be clinically significant. This would agree with findings of Wilson et al who utilized a ^{131}I- renogram for post-operative follow-up in patients undergoing ureterosigmoid diversion.[18] In their small group of patients, hydroureter associated with a normal renogram always had a good prognosis with further follow-up examination.

Of some concern is the high incidence of abnormal examination with both procedures in the current patient population (Table 2). Nearly half of the EXU's were abnormal and approximately two-thirds of the CRSP's were abnormal. This is due, in part, to the relatively strict criteria utilized for judging abnormalities with the two procedures. Most of the urographic abnormalities were minor and would not be expected to result in clinical intervention. Many of the minor deviations from normal in the CRSP would likewise not be expected to result in clinical intervention.

A number of significant functional abnormalities were noted in the group of patients with a normal EXU and abnormal CRSP. Wilson and co-workers also found that mild renographic abnormalities were frequently associated with a normal EXU and, in a few, there was progression to more severe abnormalities.[18] Serial evaluation of our patients should help determine if these functional changes precede anatomic abnormalities or occur independently. If these functional alterations precede anatomic changes, the CRSP might allow earlier appropriate clinical intervention and hence improve patient management. Progressive functional deterioration unaccompanied by anatomic alterations might present a more difficult problem but the CRSP allows us to accurately measure this and determine if clinical intervention effectively alters the course of the disease.

(continued on page 43)

NEUROLOGICAL CHANGE FOLLOWING SPINAL CORD INJURY: AN ASSESSMENT TECHNIQUE AND PRELIMINARY RESULTS

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Historically, spinal cord injury has been viewed as a disease which occurs instantly and lasts permanently. Beginning with World War II and the resulting large number of spinal cord injured, special attention was directed toward the development of spinal cord injury (SCI) rehabilitation centers. The prevailing philosophy was then, and still remains, that once SCI occurs the neurological status is established and will not vary regardless of treatment. Also, the neurological status is generally accepted as relatively stable by the time a patient is ready to start a rehabilitation program. However, neurological changes are often seen in the acute time frame immediately following injury.

EMERGENCY MEDICAL SERVICES

Even those who insist that the initial injury is permanent do acknowledge that the condition can worsen as a result of improper handling. Congress considered this fact when it enacted the Federal Emergency Medical Service (EMS) Act in 1974 and specifically identified spinal cord injury as one of the seven critical care areas which must be addressed in the development of an EMS program.

This mandate requires the training of pre-hospital personnel in the early *identification, extrication,* and *management* of spinal cord injury victims. In addition, the designation of specific facilities as spinal cord injury treatment centers is required. Sophistication of Emergency Medical Services resulted in the preservation of life for the more severely injured who would surely have perished before reaching a hospital less than a decade ago.

Where EMS programs have been implemented, the consequences of major trauma have been tempered by expert handling at the accident scene, thereby, preventing secondary injury. This experience indicates that an aggressive, comprehensive system's approach to spinal cord injury, which includes emphasis on improving the knowledge and capabilities of pre-hospital emergency care personnel, may impact on spinal cord injury severity and improve the long-term prognosis for neurological recovery.

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ACUTE CARE/UMNI TESTING

Following admission to an acute treatment center, therapy may vary according to the particular medical/surgical philosophy of the institution and its physicians. The use and dosage of particular drugs (such as steroids), surgical procedures, aggressive versus conservative handling, differ from hospital to hospital. Much of the time, the basis for a therapeutic program is not scientific data, but rather subjective reports. In the event of a total cure-success program, this type of report may be acceptable. However, when success or failure is based on gradations of effectiveness, a quantitative descriptor which documents neurological change following a specific intervention is more appropriate than a subjective report which is susceptible to experimenter bias.

All too often the literature contains individual case studies in which subjective classification methods are utilized. These studies must be viewed with sketicism, since initial severity and final outcome are not quantified, and are, thus, prone to experimenter bias. Authors simply state that their specific protocols result in better outcomes without objective quantification. The bottom line is that documentation as to the efficacy of a particular protocol requires the inclusion of an objective, quantitative measure to evaluate neurological status. Such a measure permits comparisons between groups receiving two or more different therapeutic regimens by allowing for adjustments according to initial severity.

Researchers at the University of Miami Medical School and the South Florida Regional Spinal Cord Injury System (SFRSCIS) are presently conducting a study to determine whether neurological outcome following spinal cord injury differs as a result of acute care protocols. Specifically, local community hospital acute care is being compared to the Comprehensive Acute Care Center at Jackson Memorial Hospital (SFRSCIS). In order to make a comparison that takes into account initial severity, a quantitative tool was required. As a result, the University of Miami Neuro-Spinal Index (UMNI) was developed.

The UMNI consists of two sub-scales: the Sensory and the Motor Scale. Scale scores are indicators of overall spinal cord functional capacity within the sensory and motor modalities.

The sensitivity of this instrument is useful in identifying factors resulting in subtle differences in patient outcome. Less sensitive descriptors often miss or obscure favorable factors, which by themselves produce only small change, but which in combination make substantial differences.

METHODOLOGY

All UMNI testing is performed by trained Physical Therapists. While physicians also perform neurological examination, they are often occupied with other life-saving functions, particularly in the Emergency Room. The therapists only function in this situation is to perform the UMNI examination, so they have the time to be more thorough and exact. The therapists involved in this study all have extensive experience working with spinal cord injured patients.

The total score range for this Index is 0-460 where: 0 represents no detectable function, and 460 indicates normal function. This score is the sum of the Motor and Sensory Scales.

MOTOR FUNCTION

The Motor Scale scoring system is based on muscle testing. There is general agreement in the literature that certain muscle groups are innervated by specific anatomical portions of the spinal cord. The representative muscle groups were chosen on the basis of functional significance as it correlates to level of injury (See Figure 1). Since 44 muscle groups are tested on a 5-point basis, the total Motor Scores range from 0-220.

Figure 1. MOTOR EVALUATION FORM

MUSCLE TESTING

Patient Name:_____ Test Performed By:_____

Patient #_____ Date of Test:_____

Date of Admission:_____ Level of Injury:_____

	LEFT SCORE	RIGHT SCORE	TOTAL SCORE
SHOULDER ELEVATION			
ARM ELEVATION			
ARM HORIZONTAL ADDUCTION			
ELBOW FLEXORS			
ELBOW EXTENSORS			
WRIST FLEXORS			
WRIST EXTENSORS			
EXTRINSIC FLEXORS			
EXTRINSIC EXTENSORS			
THUMB OPPOSITION			
FINGER ABDUCTION			
UPPER ABDOMINALS			
LOWER ABDOMINALS			
HIP FLEXORS			
HIP EXTENSORS			
HIP ABDUCTION			
KNEE FLEXOR			
KNEE EXTENSORS			
FOOT DORSI-FLEXION			
FOOT EVERTER			
FOOT FLEXOR			
TOE EXTENSOR			
		Grand Total	

CODE:

0 = No function

1 = A visible or palpable flicker of contraction, but no resultant movement of limb or joint.

2 = The muscle can only move normally when the limb is so positioned that gravity is eliminated.

3 = The muscle is able to move normally against gravity, but not against additional resistance.

4 = The muscle, though able to move normally, is overcome by resistance.

5 = Normal muscle power.

Figure 2. UNIVERSITY OF MIAMI NEURO-SPINAL INDEX (UMNI)

SENSORY EVALUATION FORM

Patient name: _____

Patient #: _____

Date of admission: _____

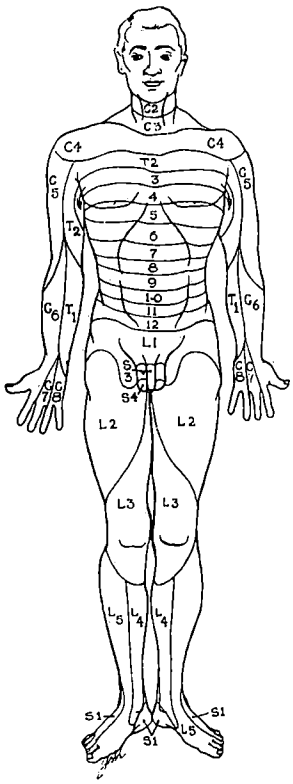
Level of injury: _____

Code:

2 = present/normal

1 = present/abnormal

0 = absent



DORSAL COLUMN FUNCTIONS (DCF): vibration

LATERAL SPINOTHALAMIC TRACT FUNCTIONS (LSTF): Pain

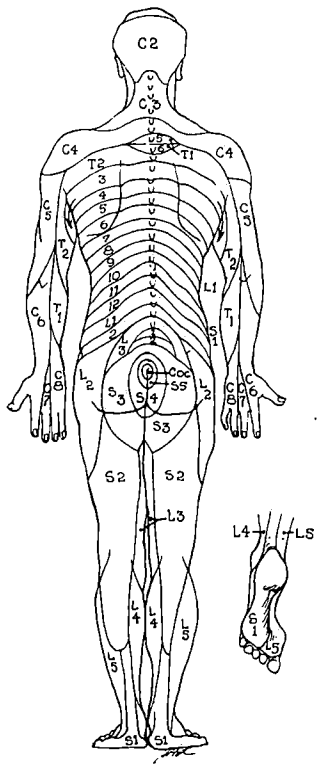
LEFT	DCF	LSTF		DCF	LSTF	RIGHT
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			THORACIC			
			1			
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			10			
			11			
			12			
			LUMBAR			
			1			
			2			
			3			
			4			
			5			
			SACRAL			
			1			
			2			
			3			
			4			
			5			
			COCCYGEAL			
			1			

TOTAL _____

GRAND TOTAL: _____

Test performed by: _____

Date of test: _____



SENSORY FUNCTION

The Sensory Scale Score is a measure of total body sensation. Within the spinal cord, two major spatially separated tracts have been identified which carry information from different sensory modalities. The lateral spinothalamic tracts are assessed with pin prick while the dorsal columns are assessed with vibration. The rationale for testing both columns is that it provides a more sensitive measure of completeness of injury. Since different skin areas or dermatomes of the body are innervated by specific levels of the spinal cord, this test also determines the level of injury for that modality. The dermatome distribution is listed on the UMNI Sensory Evaluation Form (Figure 2).

Sensory testing is performed by the Physical Therapist using standard procedures. Pain sense is determined by pin prick and vibration sense with a 256 hz tuning fork. Each stimuli is presented bilaterally to each of the dermatome areas innervated by the 30 levels of the spinal cord. Item scores are assigned as follows: 0 = absent, 1 = present, but abnormal, 2 = normal. Sensory indices range from 0 = no detectable sensation to 240 = total normal body sensation.

NEURO-SPINAL FUNCTIONAL CAPACITY RATING

The Motor and Sensory sub-scale scores can be added together to yield an overall neuro-spinal functional capacity rating. These assessments are made at stated intervals and can be used to chart progression or regression for individuals or groups of patients over a given time period. Additionally, individual assessments are sensitive to small changes, thus, the effect of specific interventions can be monitored in an on-going fashion. Differential changes of any of the sub-scales can indicate the area affected by that intervention.

The UMNI was tested for inter-rater reliability (consistency among assessors) with three Physical Therapists administering the test to 10 patients at the University of Miami Spinal Cord Injury Center, Rehabilitation facility. These multiple correlation coefficients were obtained:

Motor Scale	Mult. r = 0.85
Sensory Scale	Mult. r = 0.93

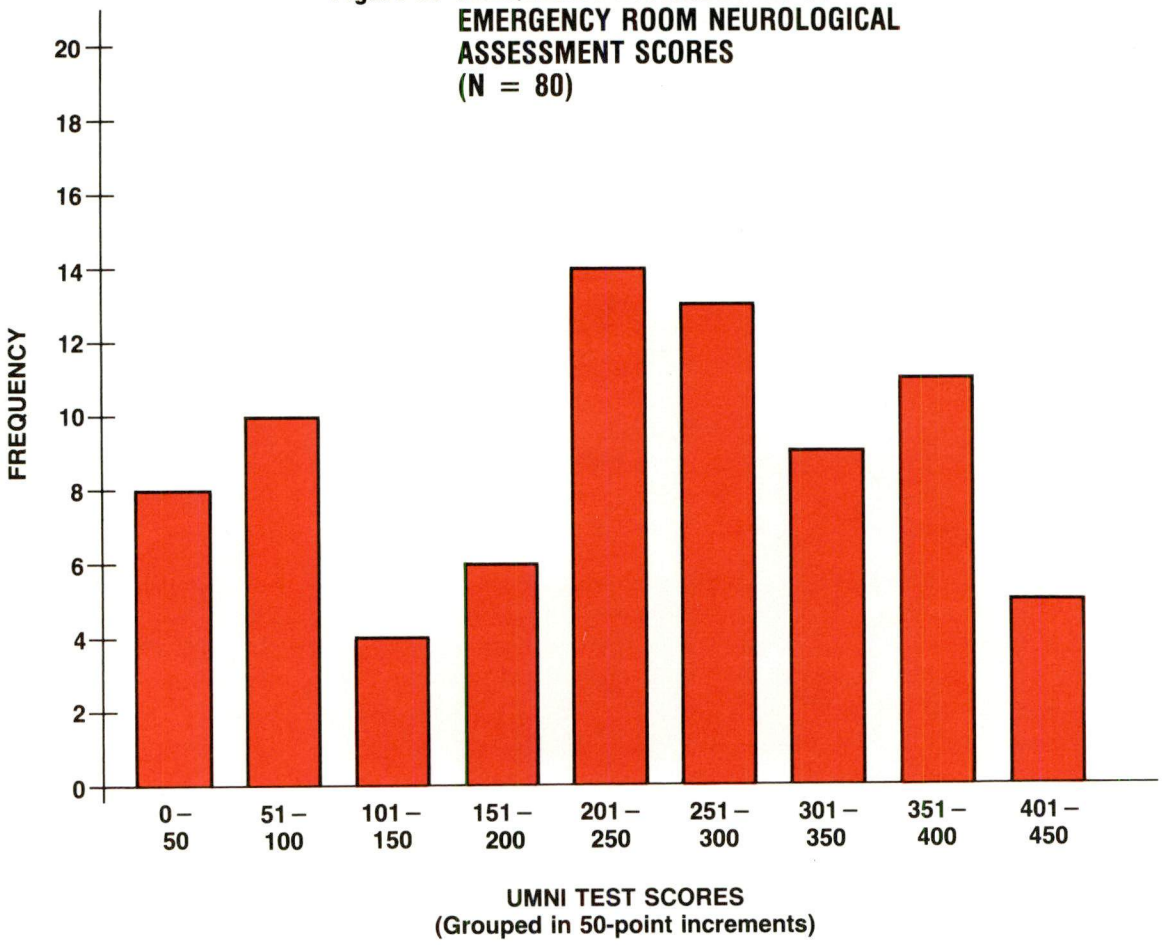
The reliability tests were made on stabilized rehabilitation patients rather than acute patients to overcome the possibility of a change in neurological status during the time between assessments. The high inter-rater reliability can be attributed, in part, to the tests' specific scoring instructions.

RESULTS

During the past two years, the UMNI has been utilized as a measure to determine "Outcome Versus Emergency Care" in a federally funded NIH-NINCDS Spinal Cord Injury Study. In this study, an UMNI assessment is made in the Emergency Room (ER), 24 hours after the ER, one-week, one-month, three-months, six-months, and one-year post-injury. To date, 99 patients have been assessed and other information, including demographic, etiologic and therapeutic data, has been collected for each of these patients. Eighteen of these were not assessed within the first 48 hours and their data will be utilized for epidemiological analysis only.

The epidemiological data for the entire population will not be presented in this paper except when relevant and pertinent to a sub-population. A bar graph (Figure 3) is used to illustrate the distribution of Emergency Room UMNI scores in 50 point increments (i.e., 0-50, 51-100, etc.). As in any long-term study, there is an attrition rate. Twenty-two patients thus far have been unable to complete the ER through one year follow-up assessments. Of these 22 patients, 13 died, three resided in a remote geographical location, three withdrew at one year (all these were near normal) and three

Figure 3. FREQUENCY DISTRIBUTION OF EMERGENCY ROOM NEUROLOGICAL ASSESSMENT SCORES (N = 80)



could not be located. The relative distribution for the most recent follow-up of the remaining patients is:

1-Week	1-Month	3-Months	6-Months	1-Year
6	6	9	12	32

One important outcome of this study is the documentation of neurological improvement over time for some of the patients, while others remain relatively stable. Some preliminary analyses have been performed on the data from the 32 patients who have completed the ER through one-year period. Keep in mind, that these analyses are based on a small population and the reader is cautioned as to the validity of the interpretation. The main reason for presenting this information is to emphasize that not all spinal cord injuries are the same, nor do they follow the same course of recovery.

Analyses were performed on the data after placing patients in either the *"poor"* or *"good"* recovery group. *"Good"* recovery is defined as an increase of 50 points or more on the UMNI over a one-year period. Seventeen patients fell into the *"poor"* group (less than a 50 point change), while 15 patients were classified as *"good"* (greater than a 50 point increase). Individual UMNI scores at the selected test periods for the *"good"* outcome group are presented in Table 1. As noted from this table, neurological changes associated with various patients do not follow the same pattern.

Table 1. TOTAL UMNI SCORES AS A FUNCTION OF TIME FOR 15 PATIENTS WITH *"GOOD"* RECOVERY.

	INDIVIDUAL UMNI SCORES						
PATIENT NO.	INITIAL ER*	24 HRS.	1 WK.	1 MO.	3 MO.	6 MO.	1 YR.
1	375	403	444	460	460	460	460
2	337	364	351	446	460	460	460
3	282	290	286	282	282	282	372
4	57	65	86	103	120	145	107
5	361	430	426	460	460	460	460
6	177	176	176	247	258	223	290
7	346	333	375	434	442	442	442
8	304	304	317	340	316	314	361
9	20	28	33	86	128	150	147
10	210	248	250	266	282	305	321
11	311	330	336	359	369	417	419
12	287	333	395	425	430	430	454
13	224	331	330	377	415	431	433
14	59	59	59	74	130	148	140
15	202	212	225	215	207	224	260

* Emergency Room

A comparison of recovery for paraplegics versus quadriplegics is presented in Table 2. As indicated by this table, initial classification as either a paraplegic or a quadriplegic was not associated with differential degrees of recovery.

Table 2. RECOVERY OF PARA VS. QUAD

	UMNI SCORE CHANGE		
NEURO STATUS	0–49	50+	TOTAL
	N	N	ΣN
Para	9	7	16
Quad	8	8	16
Total	17	15	32

Corrected Chi Square (χ^2) = 0.0000
Not Significant

The comparison of complete-to-incomplete injuries is presented in Table 3. In this instance, a significant difference is noted between groups, with the incomplete injuries demonstrating a greater degree of recovery. This finding is in agreement with that generally reported in the literature.

Table 3. RECOVERY OF COMPLETE VS. INCOMPLETE

	UMNI SCORE CHANGE		
INJURY CATEGORY	0–49	50+	TOTAL
	N	N	ΣN
Incomp.	3	9	12
Comp.	14	6	20
Total	17	15	32

Table 4 illustrates the relationship of recovery group to cause of injury. Unfortunately, the significance of this relationship could not be assessed by a Chi-square analysis because more than 20 percent of the table cells (2 of 6) were associated with expected frequencies of less than five. However, inspection of the table reveals a tendency for individuals whose injuries resulted from a fall, sporting or other activity to improve to a greater degree than those injured in a vehicular accident or by a gunshot.

Table 4. RECOVERY RELATIVE TO ETIOLOGY

INJURY ETIOLOGY	UMNI SCORE CHANGE 0–49 N	UMNI SCORE CHANGE 50+ N	TOTAL ΣN
Vehicular	6	1	7
Gunshot	6	5	11
Falls, Sports and other	5	9	14
Total	17	15	32

SUMMARY

Results from other analyses demonstrated that neither ethnicity nor financial income (above or below $10,000) were related to neurological outcome. This is encouraging in light of the frequently heard criticism that paying patients, or those of a particular race, receive differential quality of care.

As stated earlier, this patient population is quite small, and thus, it is too early to draw any firm conclusions. What is important is the evidence that changes do take place in time for many patients. This evidence refutes the belief held by some that, in all cases, once a spinal cord injury is incurred the resulting neurological deficit is permanent. Even though total recovery was not achieved by all of the *"good"* recovery patients in this study, the changes that were demonstrated by those patients do make a difference in the quality of their lives.

Periodic updating of the analyses performed in this study will be conducted. In addition, as our subject population increases, more sophisticated analyses are planned to determine:

- The relative contribution of medically related variables to patient outcome as measured by the UMNI.
- The pattern of changes in neurological status as a function of time for various types of spinal cord injuries.

Preliminary plans have been initiated to enter into a cooperative arrangement with other SCI Centers in order to enlarge the data bank at a faster pace.

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SUMMARY

Data from the current study supports the CRSP as a sensitive screening examination for upper urinary tract pathology. It would have to be accompanied by a plain X-ray of the abdomen to detect functionally insignificant urinary tract calculi.[11] Patients in whom significant abnormalities are detected by CRSP would require further urological evaluation, including an excretory urogram to determine if clinical intervention is indicated. An EXU and CRSP would still be performed as part of the initial or baseline evaluation and patients could then be serially examined only with a CRSP. This offers significant advantages over the excretory urogram, particularly for the spinal cord injured population, since there are no allergic or unpleasant reactions; bowel preparation is not required; overnight fasting or dehydration is not needed; and radiation exposure is low for patients who require frequent serial urologic evaluation.

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Vocational Placement . . .

ference in function between paraplegics and quadriplegics. More important, however, is that the vocational status of each group was independent of their Barthel Score, i.e., their functional status. Indeed, in the raw data some working quadriplegics had Barthel Scores of zero. The fact that spinal cord injured persons are hired for their ability, not disability, is illustrated by these findings.

In summary, the disabled person needs good medical care, minimal medical complications, and maximal psychological support from the rehabilitation team, family and the community—both the business and the social community.

Vocational planning and placement of severely physically disabled people, such as the spinal cord injured, is time-consuming, demanding, requires creativity, initiative on the part of highly experienced placement specialists comfortable in the world of rehabilitation and the world of work.

It is obvious that these findings support the concept that timing, continuous input, follow-up and close ties with the business community result in high percentages of positive vocational outcomes in severely physically disabled populations.

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From the Data Bank . . .

The National Athletic Injury/Illness Reporting System is an outstanding example of the necessity for, and value of, pooled data pertaining to events that have an infrequent occurance. Some of the exciting direct benefits accruing from the information generated by the NAIRS methodology include:

- Documentation of the effectiveness of the program to promulgate testing standards for Football helmets as a means of reducing serious cerebral trauma. It also documents the lack of correlation between helmet design and spinal cord injury (SCI).
- Development of information which contributed strongly to the decisions of both the National Alliance Football Rules Committee and the National Collegiate Athletic Association Football Rules Committee to make definitive rule changes further prohibiting blocking/tackling tactics that cause the helmeted head to receive the intitial force of the impact. The result was a substantial reduction in both cerebral and spinal cord injuries in high school and collegiate sports.
- Collecting information that contributed to the recent development of guidelines for the controlled use of the trampoline and mini-tramp in high school and college programs. To date, this has resulted in a near void of catastrophic injuries from these activities.

These are exciting results! It is true that the actual numbers of people who have been spared a life of living with paralysis as a result of these activities have been relatively few. However, the catastrophic nature of cerebral and spinal cord injury makes even a small reduction in the occurance of these injuries a major achievement. This is particulary so when one considers that sports injuries, according to data in the National SCI Data Bank, occur predominently to young people. ***The average age at injury is 21 years. One fourth (24%) are 16 or under. One half (53%) are under 20. Eighty-nine percent are under 30. Furthermore, the injuries to the spinal cord resulting from sports are severe. Ninety percent result in quadriplegia with 53 percent of these being complete injuries. The lifetime social and medical costs of each case may exceed a quarter of a million dollars.*** The National Athletic Injury/Illness Reporting System concept has indeed made an important contribution by reducing these injuries.

STATUS OF NATIONAL DATA BANK
(as of July 7, 1980)

	ENTRIES TO-DATE	
INJURY YEAR (FORM I)		
1973	223	
1974	429	
1975	631	
1976	688	
1977	723	
1978	865	
1979	898	
1980	12	4469
FOLLOW-UP YEAR (FORM II)		
Year 1	2907	
Year 2	2257	
Year 3	1614	
Year 4	1002	
Year 5	527	
Year 6	192	
Year 7	37	8536

The Rehabilitation Services Administration Regional Spinal Cord Injury System Project is in a position to make a similar contribution to the prevention of sports injuries. Through its Model SCI Systems, it can identify a large population of persons injured in sports-related activities. It can define etiological factors and pinpoint targets amenable to preventative measure.

The excellent public awareness program designed by the Northwest Regional SCI System (Department of Physical Medicine and Rehabilitation, University of Washington, Seattle) with its superb audio-visual package, is an example of such an application. That Program has been adopted by several of the Model Systems. We will not be able to measure the effectiveness of these campaigns but, if they collectively succeed in preventing even one quadriplegic, they have been worth the effort.

As of April 1980, 4,280 cases of traumatic spinal cord injury had been reported to the National SCI Data Research Center. Five hundred eighty-one (14%) were caused by sport-related injuries. A frequency distribution of the "Sports Injury" etiology category shows that Diving led the list with 365 cases (63% of all sports injuries). Football was second with 43 (7%); Trampoline was third with 29 (5%); and, Wrestling was fourth with 16 (3%).

A number of effective prevention programs could be developed if we had further information pertaining to the circumstances of the injury. Unfortunately, the current level of data input does not permit this. We do not know how many Diving accidents occur in streams, rivers and lakes and how many in regular pools. What was the skill level of the injured person? Was alcohol use, horse play, etc. a contributing factor? Current data does not answer such questions as these.

Dr. Clarke's statistics are based on injuries occurring in organized sports. He has little information regarding such sports activities as water and snow skiing, surfing, rodeo, and horseback riding. Using their identified populations of persons injured in such activities, the Model Systems could easily acquire appropriate additional data that would provide a suitable base of information that could be directed toward SCI prevention in sport injuries.

The National SCI Data Research Center has invited Dr. Kenneth S. Clarke to serve as a Consultant to SCI Sports Medicine. He will assist the National Center in developing a simple reporting methodology, similar to the one used by NAIRS, to collect retrospective and prospective etiology data. This will be particularly appropriate to the development of SCI prevention campaigns. A proposal for such a program will be submitted to the Model Systems' Project Directors in the near future.

. . . John S. Young, MD
Director
National Spinal Cord Injury
Data Research Center

EDITOR'S NOTE . . .

Author Credit was given to only Drs. Donald D. Thompson and Wayne R. Dexter for the article entitled, "Personality Characteristics of Spinal Cord Injury Patients at Injury and One-Year Follow-up" in the *Model Systems' SCI Digest,* Volume Two, Spring Issue, 1980. The other authors—listed in the "Acknowledgement" Section—were Cathy Green, BA, Virginia Regional Spinal Cord Injury System; Lynn Krause, MA, Southwest Regional System for Treatment of Spinal Injury; Dan Mayclin, PhD, Northern California Regional Spinal Injury System; and Wayne A. Gordon, PhD, New York Regional Spinal Cord Injury System.

Since the publication of the article, "The Virginia Psycho-Social Vocational Sub-System" in the *Model Systems' SCI Digest,* Volume One, Winter 1980, the authors have requested that Lee Crigler, RN, MSN, University of Virginia Medical Center and Peggy David, MSW, Virginia Regional Spinal Cord Injury System be added, in retrospect, as co-authors. Their names were omitted when the manuscript was originally submitted for publication.

In the current and future *Digests,* only the Senior Author and one other will be listed under the title of an article. If an article is submitted with multiple authors, the remaining authors will be footnoted on the first page of the article. The Senior Author should be so designated when an article is submitted for publication, otherwise the first two authors named will be listed under the title.

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Birmingham, Alabama

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Treatment of Spinal Injury
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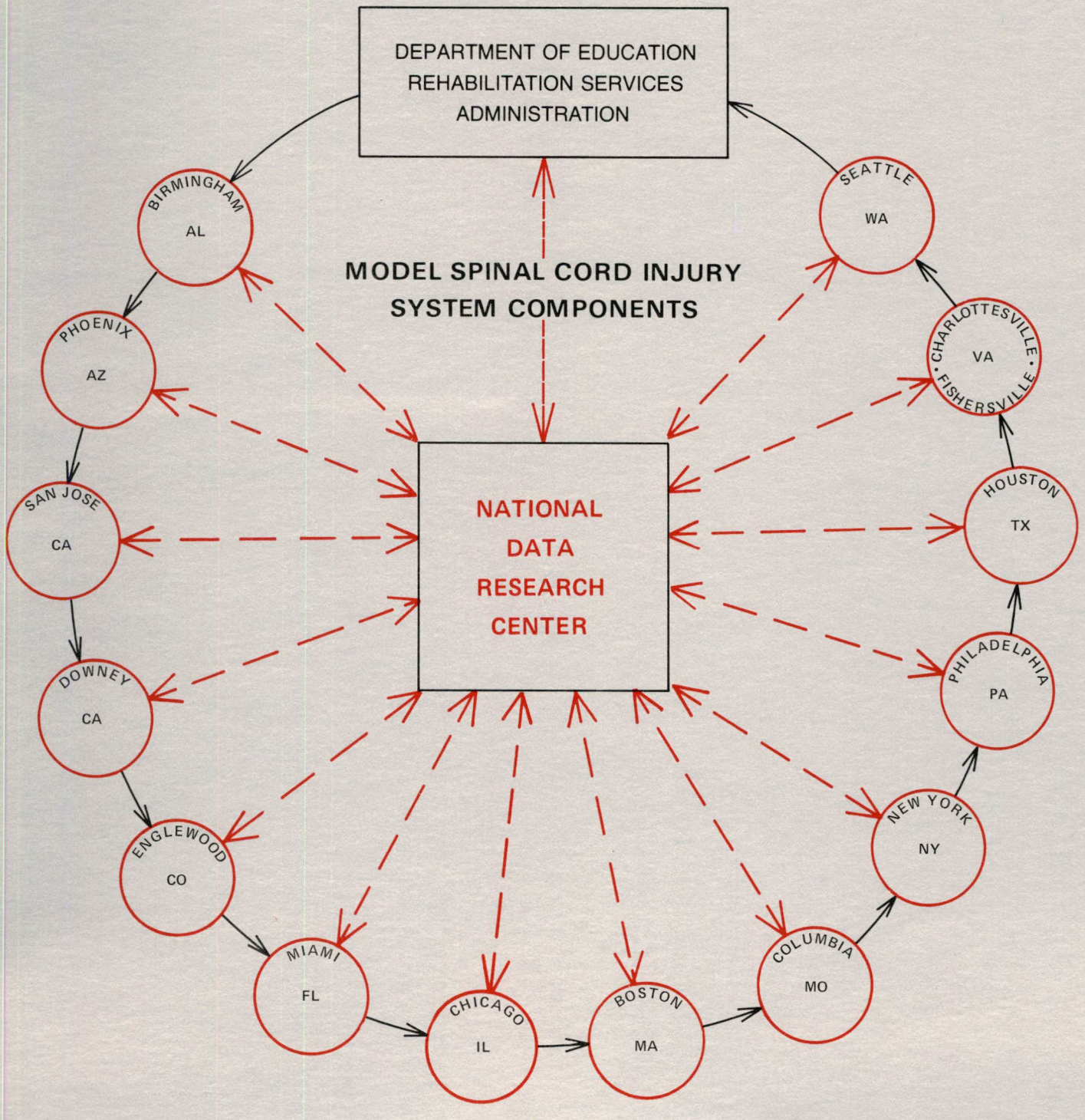
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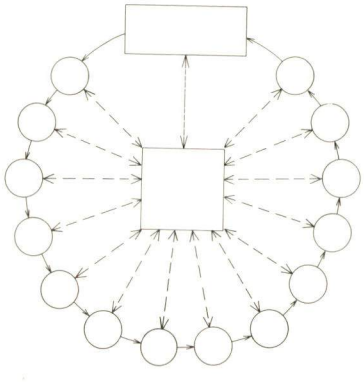
Northwest Regional SCI System
University of Washington
Seattle, Washington

MODEL SYSTEMS'

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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 U.S. Department of Education, Rehabilitation Services Administration. Each circle represents an individual Regional SCI System with the appropriate State abbreviation within the circle showing the location of each.*

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NOTE: *Model Systems' SCI Digest,* Volume One, Fall 1979 and Winter 1980 are out-of-stock.

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FROM THE DATA BANK . . .

SURVIVAL AND QUALITY OF LIFE



John S. Young, MD

The featured guest for this issue, Dr. Robert R. Menter, focuses our attention on the ultimate spinal cord injury rehabilitation goal—a meaningful and enjoyable life. Good health is certainly an essential ingredient of enjoyable living. In spinal cord injury, it is actually a precursor to achieving that goal. As a consequence, in the past, we have emphasized the medical aspects of spinal cord injury care. The impaired individual is skillfully maneuvered through the treacherous shoals of medical complications characteristic of the early post-injury period. Further, he is carefully taught how to avoid medical complications arising as a consequence of his spinal cord injury. For what purpose? So that he is able to pursue those private goals that are important to him. That is the ultimate goal!

This endeavor is a shared responsibility of the SCI treating professionals and the injured person. The latter cannot submit his person to the process and passively await achievement. By the same token, we cannot play Pygmalion. Our patients and their subsequent lives are not our creations. Their successes are their successes! We have only helped.

Barry Corbet points out this partnership between the treating and the treated in his book, *Options**.

"Basic rehabilitation is a drag. It teaches you what you learned in the first four years of life—mobility, personal hygiene, avoidance of hazards, muscle development and other pretty unoriginal stuff. The best thing going for it is that not doing it is much worse than doing it.

But that's just Rehab 101. If you're in a good place, you can attend a Sexual Attitude Reassessment seminar, (sounds ominous, but they show you lots of dirty movies), learn to drive a car (takes 10 minutes if you've driven before—instant freedom!), join group sessions on relationships, self-image, self-presentation, or whatever else needs discussion, receive vocational counseling and training, learn about money sources, get in some recreation and maybe get out on the town and mix with some normies. (They're pretty weird, but you get used to them.) Lots of good information here, and even some good fun. Enter rehabilitation with a full heart.

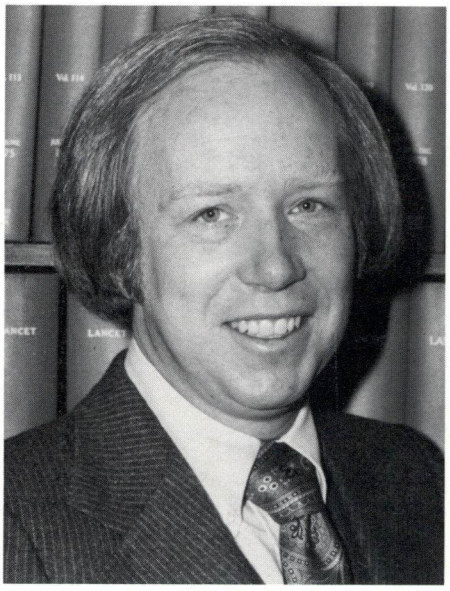
* Available through: National Spinal Cord Injury Foundation; 369 Elliot Street; Newton Falls, MA 02164

(see Data Bank, page 8)

SPINAL CORD INJURY CARE (BEYOND SURVIVAL) 1980

Robert R. Menter, MD
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Rocky Mountain Regional
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Classic approaches to understanding, treating and rehabilitating survivors of spinal cord injuries (SCI) have traditionally centered around the altered physiologic systems of the victim. The regulation and long-term maintenance of these alterations has led to a high survival rate. Frequently, however, we have concentrated on the elements of survival to the exclusion of other areas of treatment. The medical model which deals with survival has served us well as a start, but alone, it is inadequate to meet all the needs of the spinal cord injured individual.



Robert R. Menter, MD

During the past 20 years, with the development of modern spinal cord injury care systems in the United States, we have changed previously fatal outcomes into usually stable, indefinitely long survivals. Many factors have contributed to this change in outcome, the foremost being the advent of modern antibiotics and Emergency Medical Systems (EMS). This provides optimum survival potential for the victim from the scene of the accident to the hospital and through the acute medical care phase.

The time has now come that we, as a group of health care professionals, must look beyond the problems relating to survival to those pertinent to the quality of life of SCI victims. Quality of life is not a new issue for the spinal cord injured. Many have spoken to this issue before but, for the most part, their concerns have been relegated to the background, due to the pressing problems of solving and stabilizing the medical model (i.e., skin, bowel, bladder and loss of mobility problems).

Physicians, traditionally the leaders of spinal cord injury care teams, should readjust their orientation to non-medical problems—such as, the psychological, social and vocational problems that are involved in achieving a successful lifestyle—as opposed to exclusive emphasis on survival. To be sure, quality of life is not an issue if the patient's medical program is not well managed, but adequate medical treatment alone does not meet all of the needs of the patient.

What are these needs? Obviously, we have much to learn, but at this time, at least eight major factors contribute substantially to successful lifestyles and self-fulfillment of the spinal cord injured. Each of these factors interfaces and interacts in adjoining areas. We cannot isolate specific factors and focus on them individually to the exclusion of others. The following are the major factors that must be considered:

- Foremost is a stable medical program, covering the basic skin, bowel, bladder and loss of mobility problems, with life-long follow-up and support in these areas.
- Housing and attendant care for those who require such assistance.
- Financial stability and security.
- Transportation.
- Vocational opportunities.
- Sexual identity and role.
- Self-esteem or importance to others.
- Recreational or self-realization activities.

Let's take a look at each of these areas and try to assess our position.

THE MEDICAL MODEL OF SKIN, BOWEL, BLADDER AND LOSS OF MOBILITY

As previously mentioned, we have the skills to manage and care for the medical problem areas if funding is available, and the patient is referred to SCI Centers with expertise in spinal injury care. We still encounter individuals who, through no fault of their own, have received less than adequate care and, in many cases, have stumbled along for years not knowing what was available or possible for their particular condition. Once stability and control of their medical disorders have been established, the continuum of support, maintenance of lifetime follow-up is all too often lost. A stable medical program often lulls the patient and/or the staff into a sense of complacency and turns their attention to other problems, resulting in neglect of the fundamental need for lifetime support and follow-up. Frequently, funding for lifelong medical care becomes a negotiable pawn in varying forms of settlements. Lastly, all too often, established spinal injury centers are overwhelmed by the acute care injuries and their management and have little time for the critical factors of follow-up lifetime care.

SATISFACTORY HOUSING AND ATTENDANT CARE FOR THOSE REQUIRING IT

Attendant care is required to one degree or another for all patients paralyzed at the cervical 7 level or above. Indeed, in some cases, individuals at lower levels of paralysis, such as cervical 8 or a paraplegic level, may require attendant care. Specific examples would be those who are considerably overweight or physically impaired in such a manner that they cannot perform in a manner typical of their levels of paralysis. Specific medical disorders, such as heterotopic ossification, which impairs mobility of the hip, knee or shoulders, may prevent a person from achieving an optimal level of function.

Housing for spinal cord injured victims is generally inadequate in most parts of the country. Options for those people now owning their homes is limited. Public housing requirements for the handicapped are often inconsistent with the handicapped population it is trying to serve. For example,

an individual who requires only a minimum of attendant care may be refused public housing because he clearly cannot state that he could live by himself 24 hours a day without help.

Another problem results from trying to mix the SCI handicapped with an older group of people who have similar physical limitation and accessibility needs. The younger age-range of spinal cord injured individuals normally tends toward enjoyment of rock and roll music, parties at night and other forms of entertainment, which are disturbing to the older group and, thus, make the mixture of these two dissimilar populations unlikely to succeed.

Attendant care frequently becomes the battleground between advocates representing the party with financial responsibility and those representing the spinal injured individual's interests. It is important that we, as professionals, exercise one independent professional judgement in each individual case.

FINANCIAL STABILITY AND SECURITY

The term "financial disincentives" has rushed to the forefront of current issues involving funds for the spinal cord injured. This clearly indicates how little attention has been paid to the nonmedical problems of the spinal cord injured patient. The term "financial disincentives" is most often used to describe the so-called S.S.D.I. and S.S.I. Programs. People receiving these benefits cannot risk venturing into the real world of employment to earn money for fear that they will lose these benefits and the meager security they provide. Financial security is further eroded by rampant inflation.

Another major inconsistency in our approach is the tendency in some jurisdictions to give additional financial support to individuals in the guise of "attendant care" provided by members of the household. Frequently, examination of these attendant care services and their reimbursement shows that the individual does not need attendant care but, in reality, needs additional income. This misuse of the term "attendant care" to provide additional financial support creates great distrust and misunderstanding relative to attendant care and, thereby, further complicates the process of obtaining those services for the individuals who really need them.

TRANSPORTATION

Although many efforts have been directed at establishing public systems for handicapped transportation, their success has been limited to the high population density of centralized metropolitan areas. Rural, small metropolitan, and sprawling metropolitan areas remain, for the most part, totally unaffected by these efforts. Even when such systems are available, the handicapped population frequently finds itself capitve to problems of pre-scheduling, delays in arrival, limited hours of operation and extremely high service cost. What is needed is low cost, fuel efficient, individual transportation devices. Presently, handicapped individuals are totally dependent upon the fuel-inefficient, expensive modified vans that are unattainable by many individuals.

Ironically, low cost individual transportation devices are available in European countries but cannot be used in the United States due to safety deficiencies as determined by Federal Guidelines. A major effort must be made to solve this problem, either by developing specific American devices, modifying European devices, or changing Federal Safety Guidelines to meet the needs of the handicapped population.

VOCATIONAL OPPORTUNITIES

Difficulty in vocational placement of the spinal cord injured increases with each increment of paralysis. Studies show that far more jobs exist for handicapped individuals than applications made, yet successful vocational placement is the exception rather than the rule. Major factors preventing realization of vocational opportunities are financial disincentives and transportation problems.

Concern is developing over trends emphasizing the process of retraining rather than placement with existing skills. Frequently, people with severe handicaps can be placed with their existing skills without going through elaborate retraining processes. This direct placement is based upon two evolving trends in employment:

- *COTTAGE INDUSTRY (Home Job Setting):* This particular model emphasizes the use of sophisticated communication systems, such as cathode-ray tubes, to connect the individual's living environment and the specific resource areas that he needs for completing a specific task.
- *TECHNOLOGY TO MODIFY JOBS FOR HANDICAPPED INDIVIDUALS WITHIN THE PREVIOUS EMPLOYER'S FIRM:* This particular task requires someone who is familiar with the techniques available to modify a work setting for various severities of physical impairment.

A new vehicle for effective vocational placement is the private employment services, specializing in the handicapped. Considerable interest is focusing on a comparison of the private sector and its ability to provide this service with that of Federal and State programs offering similar services.

SEXUAL IDENTITY AND ROLE

A great deal of attention has been given to sexuality after spinal cord injury, just as it is directed at sexuality in all spheres of our society. Many important strides have been made in spinal injury Centers in the area of sexual counseling. However, these services have yet to be fully provided in all spinal injury treatment centers and to all victims of spinal cord injury. In many cases, the financially responsible party doesn't understand the importance of this vital ingredient in case management outcome and is less than supportive in its financial reimbursement for those services.

We can no longer bury our heads in the sand and pretend that sex is not a vital factor in the disabled population. It is hard for any individual, able-bodied or disabled, to have positive personal identification when he lives a neutered, eunuch-type existence. Sexual identity and roles go far beyond the concept of a sex act. Sexuality, in its broadest perspective, is a concept of feelings, tenderness, caring and understanding other people's feelings.

SELF-ESTEEM OR IMPORTANCE TO OTHERS

Spinal cord injury frequently impairs an individual's ability to contribute to the family and forces him to draw upon the family's resources to meet his own needs. This dramatic reversal from a positive to a negative role eliminates, in many cases, the ability of a person to see himself as an important, necessary part of his family unit. The financial disincentives, we have already discussed, frequently prevent him from assuming a new vocational role which might reverse his dependency on other members of the family unit. The current factors of inflation and inability to enter into the active work force, in many cases, cause the individual to fall further and further behind economically, only serving to increase his depression.

Those outside of the family unit, such as friends and former fellow employees, frequently see him as a non-worker not knowing that financial disincentives have forced that role upon him. The American society is basically governed by a work ethic, and those people who do not work are generally categorized as inferior people.

RECREATION AND OTHER SELF-REALIZATION ACTIVITIES

We are just awakening to the potential of handicapped people to participate in all types of recreation, including competitive activities such as marathons, track and field, basketball and winter sports, as well as general recreational activities such as hunting, fishing, camping, sailing and swimming.

An often overlooked, but significant, item is the simple need to take vacations or trips. How often do we hear able-bodied people talking about their need to get away on vacation, yet how often do we encourage it for the disabled person?

Few spinal cord injury centers in the United Stated have been able to explore these areas, primarily because they are not reimbursable services. A program at Craig Hospital in Englewood, Colorado, has been extremely fortunate to receive substantial financial support from a charitable organization whose funds are exclusively designated for Recreational Therapy Programs. From experiences with this program, we know that successful exposure of handicapped individuals to recreational activities enhances their lifestyle and creates a more positive self-image, which overall results in fewer medical complications and greater participation in family and peer social structures.

DISCUSSION

The integration of these eight areas into a total system of lifetime follow-up care for the spinal cord injured will require new approaches and skills. Patients must be educated, not only in the medical and physical aspects of their disability, but the social skills necessary to deal with the able-bodied population and environment. The key to the 80's will be the development of social skills training programs which, when coupled with adequate medical and physical restoration programs, will provide a framework for disabled individuals to function effectively in their new environment. These programs should not be confused with traditional psychology counseling approaches which have been too narrow in scope, tending to isolate emotional responses from health, mobility and environment.

CONCLUSION

In conclusion, the time has come for all professionals involved in treating spinal cord injury victims to give their full, wholehearted support to the area of psychological, social and vocational adjustment. We need not be threatened by the emphasis on these factors, for they will serve to round-out the treatment program and can in no way substitute for the need of a quality medical program and lifetime medical follow-up.

ACKNOWLEDGEMENTS

The author acknowledges, with thanks, the contribution of Scott Manley, EdD and Ms. Bonnie Sims of Craig Hospital for their valuable reflections on the content of this manuscript.

RESEARCH NOTE

Members of the Missouri Regional Spinal Cord Injury System (MRSCIS), University of Missouri Health Sciences Center, have initiated research into the incidence, circumstances, and character of spinal cord injuries (SCI) occurring on "Waterslides" throughout the country. Waterslides are the latest innovation in water recreation—the participant, seated on a foam rubber mat, is propelled by a fast moving stream of water down a concrete slide into a receiving pool at the bottom of the slide.

Contact with the other Regional Model SCI Systems resulted in the identification of several individuals who received spinal cord injuries while participating in this newest form of water recreation. All the identified cases were classified as quadriplegics.

Since it is likely that more waterslide spinal cord injuries occur than are treated in Regional SCI System facilities, we are seeking your cooperation in identifying other waterslide SCI victims who are receiving treatment elsewhere. If you know of any such injuries, please contact Ellen Cadwell, RRA, Spinal Cord Project, Rusk Rehabilitation Center, Columbia, Missouri 65212 (314-882-1176). We will be collecting data on: date of injury, city and state of injury, age, sex, level and type of injury, and medical facility in which treatment was initiated.

Data Bank . . .

Remember that the genuine aim of rehabilitation is to achieve your goals. Tell them what you want to accomplish, show them that you're willing to work, and they'll literally give you the world. And consider that the various therapists—Occupational, Physical, Speech, GU, Sexual and Recreational—are specialists and can't be expected to intuit your overall needs. Make it your responsibility to bring their skills together to achieve your goal. And what's your goal? To escape, of course."

Escape from what? In context, Corbet is speaking of escaping from the regimented life in the Spinal Cord Injury Center. In a broader sense, he is speaking of escaping from the social and psychological prison that is spinal cord injury.

We have all been keenly aware of our obligation to provide training in social skills in addition to physical skills. It is encouraging to see innovative approaches that enrich the armamentarium of our patients (soon to become people again) to be used in their forth-coming battle with a grim new world. We are on the threshold of that era of sophisticated spinal cord injury care envisioned by the early leaders in the field. Dr. Herbert Talbot, former Chief of the Spinal Cord Injury Service, Veterans Administration Hospital, West Roxbury, Massachusettes wrote on the occasion of Sir Ludwig Guttmann's 70th birthday (*Paraplegia*, 7, 148, 1970):

"Sir Ludwig Guttmann has been one of the few to realize, and he stands quite alone in having demonstrated that our disabled brethren no more live by bread alone than do the rest of us. The quotation, often repeated, is usually left incomplete. Emerson borrowed it from Deuteronomy but amplified it. What he said was, "Man does not live by bread alone, but by faith, by admiration, by sympathy." It is not enough to teach the disabled how to keep alive and earn a living. We must help them to find the joy of living, to regain their faith in themselves, to feel again the glow of being admired, to know the solace of sympathy. And this requires more than organization and techniques. It calls for that combination of compassion and imagination which have ever been the mark of the great physician. In no other activity does the science of medicine need more to be complemented by the art.

***Over the years I have many times repeated that rehabilitation must be a product of its time and place; it must serve here and now and it must, by the precepts of Western civilization, acknowledge the primacy of the individual. Parenthetically, it is worth remarking that the individual may attain a high level of self-expression and self-satisfaction when he relates his efforts to those of a group. This has been one of the most moving and significant aspects of the development of sports for the disabled. But however it may be sought, this longing for fulfillment that lies in every heart, this urge of every man to be somebody, to be something, but above all to be himself must never be far from our thoughts. Without it, the processes of rehabilitation become no more than a mechanical* tour de force."**

STATUS OF NATIONAL DATA BANK
(as of Oct. 6, 1980)

	ENTRIES TO DATE	
INJURY YEAR (FORM I)		
1973	223	
1974	428	
1975	622	
1976	713	
1977	848	
1978	888	
1979	829	
1980	93	4644
FOLLOW-UP YEAR (FORM II)		
Year 1	3030	
Year 2	2362	
Year 3	1709	
Year 4	1054	
Year 5	566	
Year 6	236	
Year 7	70	9057

Ten years later, Dr. Menter reminds us again that survival alone is not enough. We must concern ourselves with the quality of life of those that have placed themselves unto our care.

. . . John S. Young, MD,
Director
National Spinal Cord Injury
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Phoenix, Arizona

SPINAL CORD INJURY SYSTEM INVOLVEMENT IN FOLLOW-UP MEDICAL CARE

John S. Young,* MD
Nancy E. Northup,† MSS
National Spinal Cord Injury
Data Research Center
Phoenix, Arizona

The Regional Spinal Cord Injury (SCI) System concept requires the development of a mechanism for long term comprehensive follow-up. This includes medical, social, psychological and vocational follow-up on a scheduled basis. The optimal role and the ideal practical degree of involvement of the Regional Spinal Cord Injury Center in ongoing medical care has not been precisely defined or demonstrated. Theoretically, if one accepts the concept that the spinal cord injured person presents unique problems in medical and surgical diagnosis and treatment, and requires the same multidisciplinary, specialized approach to recurring medical and surgical conditions as was provided during his initial post injury period; it seems logical that this care should be given in the Regional Spinal Cord Injury Center. Extending this concept a step further, it would also seem logical that complete medical management, both inpatient and outpatient, should be the sole responsibility of the physicians and allied health professionals of the Regional Center. However, many practical interacting factors compromise this theoretically ideal system of management. Complete primary care may not be the most efficient or proficient method of service.

The Common Data Base used in the Model SCI Regional Systems includes a variable defining categories of medical care to document various degrees of involvement of the Regional Spinal Cord Injury Center in ongoing medical management. The category of follow-up care is reported for each case at the time of initial discharge and annually thereafter.

An additional measure of the SCI Center's involvement in follow-up medical care is re-hospitalization in the Center following initial discharge. Again, the theoretical ideal would be the admission of all cases to the SCI Center for treatment of all medical and surgical conditions. However, as with primary care management, many factors make this impractical.

This paper presents the combined experiences of the Regional Model SCI Centers in providing ongoing medical care.

CATEGORIES OF MEDICAL CARE

The distribution of cases among the several categories of follow-up care is presented in Table 1. There is obviously multiple counting. Cases reported in the later years were also reported in earlier years. The reported cases were injured during the period 1973–1978.

---

* Director
† Manager, Analytical Services

Table 1. CATEGORY OF CARE BY FOLLOW-UP YEAR

CARE CATEGORY	FOLLOW-UP YEAR									
	YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5	
	N	%*	N	%*	N	%*	N	%*	N	%*
Primary Care	325	14.3	214	12.6	142	12.6	74	10.7	38	10.0
Major Consulting	672	29.6	465	27.5	259	23.0	153	22.0	75	19.7
Minor Consulting	810	35.7	607	35.9	410	36.4	271	39.0	153	40.3
Data Only	386	17.0	360	21.3	289	25.7	177	25.5	106	27.8
Lost	8	0.4	9	0.5	3	0.3	5	0.7	0	0.0
Dead	31	1.4	23	1.4	12	1.1	7	1.0	7	1.8
Other**	37	1.6	15	0.8	10	0.9	7	1.0	1	0.3
TOTAL CASES	2269	100	1693	100	1125	100	694	100	380	100

* Percent of year total

** Not applicable

10/80

PRIMARY CARE

In this category, the patient remains under the continuing care of the SCI Center physicians and consulting staff who serve as the patient's primary physicians. Inpatient and Outpatient Services are supplied by the SCI Center for treatment of almost all of the patient's medical and surgical problems. Only 14.3 percent of the cases were being provided this type of follow-up one year after injury. This gradually decreased to 10 percent at year five.

There was considerable variation among Centers in the number of cases in this category. Eighty percent of all cases were contributed by only four Centers. Among other things, this probably represents an honest philosophical difference of opinion among the Centers in the role of the Center in ongoing medical management.

MAJOR CONSULTING CARE

In this category, the patient is under the care of physicians other than SCI Center physicians for minor medical problems that may arise. The patient returns to the SCI Center for treatment, on an inpatient and outpatient basis, of major SCI related medical or surgical problems such as skin, urological, respiratory, autonomic, orthopaedic. Other major medical or surgical problems unrelated to spinal cord injury, such as pregnancy, are also managed in the SCI Center hospital.

Almost 30 percent of the reported cases were discharged to the category of Major Consulting Care. As with Primary Care, this gradually decreased to 20 percent over the five-year period. The distribution of cases in this category was relatively consistent among the SCI Centers. The two categories, Primary Care and Major Consulting, offer a high level of control over follow-up medical care. However, by the end of the fifth year post-injury, this control extended to only 30 percent of the cases being followed.

MINOR CONSULTING CARE

In this category, the patient is under the care of physicians other than SCI Center physicians for most medical or surgical problems that may arise. The attending physicians may or may not consult with the SCI Center physicians when treating such problems. The patient may be referred back to the SCI Center for treatment of some major medical or surgical complications or for periodic evaluation, recommendations and/or treatment. This mode of follow-up medical care is the most

prevalent for all cases. The Minor Consulting Category is a lower level of medical involvement. The percentage of cases being followed in this category appears to remain relatively constant over the years following discharge.

DATA COLLECTION ONLY

In this category, the patient is under the care of physicians other than SCI Center physicians. The physicians and staff of the SCI Center do not participate in the continued care of the patient. However, the patient's location is known and periodic information can be obtained from either the patient or his physician, social worker, nurse, counselor, etc. The number of cases in this category gradually increases from 17 percent in the first year to 28 percent in the fifth year following injury. The Regional SCI Center has no medical involvement in the care of these patients. They may, however, be considerably involved in the social-vocational aspects of the individual's rehabilitation program.

LOST TO SYSTEM

The patient's location, in the Lost to System Category, is unknown and no channels of communication exist to permit data collection. As a result of a rather herculean data collection effort by all Centers, an amazingly small number of cases are lost to the data collection process. The majority of these are unwilling to release medical and other information or, for some reason or other, have elected to sever all ties with the SCI Center.

DEAD

The cases in this category represent those alive at the end of the previous year who died within the year being reported. The average death rate, 1.4 percent or 14/1000, is higher than the 1977 U.S. death rate of 8.9/1000.

NOT APPLICABLE

No further data collection is required: such as those patients who achieve neurological recovery. A small number of cases achieve a complete or almost complete neurological recovery. As a consequence, they are no longer considered spinal cord injured and are dropped from continued follow-up.

RELATIONSHIP OF CATEGORY OF FOLLOW-UP CARE TO EARLY INITIAL ADMISSIONS

Undoubtedly many factors determine the category of care provided in each individual case. These include proximity of the individual's residence to the SCI Center, availability of service funding, and the effectiveness of the referral mechanisms between the Center and referring physicians. These same factors probably contribute to the initial early referral of the individual to the System following injury. If this hypothesis is true, there should be a higher involvement of the SCI Center in the medical follow-up in those cases that were admitted to the Center early following their injury.

EARLY/LATE ADMISSIONS

In Table 2, the category of follow-up care between those cases admitted to the System early following their injuries are compared to those admitted late. The approximate median time from onset of injury to System admission for all cases is 21 days. Cases in the "early" group were those that were admitted less than 22 days from onset of injury—the "late" group was admitted more than 21 days after injury. As expected, the difference between the two groups is significant. In all follow-up years, the SCI Center remained more involved in continuing medical care for those in the "early" admission group.

Table 2. COMPARISON OF CATEGORY OF FOLLOW-UP CARE BETWEEN EARLY* AND LATE SYSTEM ADMISSIONS

CARE CATEGORY	FOLLOW-UP YEAR							
	YEAR 2		YEAR 3		YEAR 4		YEAR 5	
	EARLY	LATE	EARLY	LATE	EARLY	LATE	EARLY	LATE
	(NO. CASES)		(NO. CASES)		(NO. CASES)		(NO. CASES)	
Primary Care	143	71	92	50	49	25	29	1
Major Consulting	269	196	154	105	94	59	39	9
Minor Consulting	279	328	192	218	120	151	77	36
Data Only	143	217	105	184	68	109	45	76
Chi Square (X^2) Statistical Test	55.72 Sig. beyond 0.01p		45.04 Sig. beyond 0.01p		29.24 Sig. beyond 0.01p		57.16 Sig. beyond 0.01p	

* Initially admitted to System less than 22 days from onset of injury.

10/80

RE-HOSPITALIZATION IN FOLLOW-UP YEARS

One of the most effective measures of the involvement in follow-up care by the Regional SCI Center is the extent to which it participates in the re-hospitalization needs of its discharge patients. Theoretically, at least, the spinal cord injured can best be cared for in a hospital that is staffed, equipped and experienced in the unique medical and surgical characteristics of spinal man.

The National Data Base as a part of the follow-up mechanism contains reports of each re-hospitalization following initial discharge. Examination of the re-hospitalization data provides information relevant to determining the involvement of the SCI Center in this aspect of care.

The ratio of days re-hospitalized in System hospitals over total days re-hospitalized for successive Follow-Up Years is presented in Table 3. Approximately half of the re-hospitalization days utilized occur in the SCI System Hospital. While it appears there is a slight degradation over the Follow-Up Years, it is probably not significant. Although the numbers suggest a tendency to treat a higher

Table 3. RATIOS OF DAYS REHOSPITALIZED IN SYSTEM HOSPITALS TO TOTAL DAYS HOSPITALIZED

NEURO CATEGORY	FOLLOW-UP YEAR							
	YEAR 2		YEAR 3		YEAR 4		YEAR 5	
	DAYS (N)	AVER. RATIO	DAYS (N)	AVER. RATIO	DAYS (N)	AVER. RATIO	DAYS (N)	AVER. RATIO
Para—Incomplete	96	0.521	54	0.432	26	0.359	14	0.242
—Complete	261	.573	146	.522	96	.550	46	.462
Quad—Incomplete	195	0.587	104	0.544	48	0.460	26	0.560
—Complete	306	.657	173	.552	101	.527	42	.512
TOTAL DAYS	858	0.597	477	0.528	207	0.507	128	0.474

10/80

percentage of quadriplegics and complete injuries in System hospitals, an analysis of variance determined that the differences in neurological categories are not statistically significant.

As hypothesized in analysis of the Categories of Follow-Up Care, many of the factors contributing to the initial early referral of newly injured cases to the SCI Systems should remain operative

Table 4. RATIO OF DAYS REHOSPITALIZED IN SYSTEM HOSPITALS TO TOTAL DAYS REHOSPITALIZED: COMPARING CASES INITIALLY ADMITTED TO SYSTEM EARLY* VERSUS LATE

	INITIAL HOSPITAL ADMISSION						
	EARLY			LATE			
FOLLOW-UP YEAR	DAYS (N)	AVER. RATIO	STD. DEV.	DAYS (N)	AVER. RATIO	STD. DEV.	F-TEST (ANOVA)
2	402	0.655	0.442	456	0.545	0.467	F = 13.005 Sig. beyond 0.05p
3	237	.594	.475	240	.462	.477	F = 10.338 Sig. beyond 0.05p
4	117	.606	.460	154	.432	.486	F = 9.672 Sig. beyond 0.05p
5	59	.550	.481	69	.410	.477	F = 2.834 Not significant

* Initially admitted to System less than 22 days from Onset of injury.

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during the follow-up years. Table 4 presents the ratio of days re-hospitalized in System hospitals to total days re-hospitalized, comparing the group of cases who were admitted to System hospitals "early" following the onset of injury with those admitted "late". "Early" is defined as <22 days which is approximately the median for all cases. The difference between the two groups is statistically significant with the "early" admission group spending more re-hospitalization days in System hospitals. This difference extends over the first four Follow-Up Years.

Information similar to days re-hospitalized is derived from the number of *cases* re-hospitalized in System hospitals versus non-System hospitals, comparing *cases* in the early and late admissions groups. In the first four Follow-Up Years, the difference was statistically significant. More of the "early" admission cases were re-hospitalized in System hospitals. See Table 5.

Table 5. NUMBER OF CASES REHOSPITALIZED IN SYSTEM VERSUS NON-SYSTEM HOSPITALS: COMPARING CASES INITIALLY ADMITTED TO SYSTEM EARLY* VERSUS LATE

	FOLLOW-UP YEAR							
INITIAL HOSP. ADMISSION CATEGORY	YEAR 2		YEAR 3		YEAR 4		YEAR 5	
	SYS. HOSP.	NON-SYS. HOSP.	SYS. HOSP.	NON-SYS. HOSP.	SYS. HOSP.	NON-SYS. HOSP.	SYS. HOSP.	NON-SYS. HOSP.
	(NO. CASES)		(NO. CASES)		(NO. CASES)		(NO. CASES)	
Early*	294	108	149	88	80	37	37	22
Late	283	173	120	119	71	83	32	37
Chi Square (X^2) Statistical Test	12.24 Sig. beyond 0.01p		7.69 Sig. beyond 0.01p		13.71 Sig. beyond 0.01p		3.16 Not Significant	

* Initially admitted to System less than 22 days from onset of injury.

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DISCUSSION

Spinal Man presents unique problems in diagnosis as well as in medical and surgical treatment. Symptoms are frequently masked by loss of sensation. Bodily functions—separated from higher center control—are altered. Reflexes, particularly visceral, are periodically and inconsistently distorted. Medications that affect the autonomic or hormonal systems are prone to disturb the delicate autonomic balance so important to the state of health and actual survival of the spinal cord injured. Anesthesia is never routine. Surgical decisions and procedures must be modified. Obstetrical management is fraught with unusual experiences.

Added to such purely medical considerations is the ever prevalent need to coordinate the medical program with the patient's psychological, social and vocational situation. For these and other reasons, it makes sense for the Spinal Cord Injury Center to be intimately involved in the continuing medical management of the spinal cord injured. The need for a categorical, centralized mode of medical management during the initial hospitalization period following injury is becoming recognized. The need for this to continue after the initial discharge is less fervently espoused but equally important.

Most of the Spinal Cord Injury Centers in the Western World endorse the concept of continued involvement of the professional staff of the SCI Center in ongoing follow-up care. Few, however, have achieved primary responsibility for the medical care of the bulk of their patients. Exceptions include the Australian Centers, particularly the Royal Perth Rehabilitation Hospital where outstanding leadership has combined with a serendipidous geographical isolation to permit a high level of involvement. (See: *A Look at Spinal Cord Injury Down Under* by William Donovan, page 15 of this issue.) In all other Centers, combinations of geographical, service funding, political jurisdictions and traditional medical referral considerations continue to errode the SCI Centers involvement in follow-up care.

Traditionally, in the United States, the ongoing medical management of discharged spinal cord injured cases has not been the responsibility of rehabilitation centers involved in their initial care. Patients are routinely discharged to the continued care of their local physicians. The level of involvement maintained by the Regional SCI Centers, as documented in this paper, is a marked departure from this traditional concept. More than half of the re-hospitalizations occur in the SCI Center. The Center continues to maintain some medical involvement in 70 percent of the cases in the fifth year. In a third of these cases, the Center plays a major role.

This level of achievement, however, is far from adequate or acceptable, and represents only the initial results of system program development. This report has not identified the major factors contributing to the SCI Centers' inability to maintain a higher level of medical involvement. Undoubtedly, these factors include large geographical separation, availability of funding for services, jurisdictional limitations for agency funding, traditional medical referral concepts, and availability of beds for readmission of chronic cases with recurring complications. Many of these factors are beyond the SCI Centers' control. However, the Centers are, by documentation and demonstration, exerting a major influence contributing to change.

With the development of more SCI Centers, better service funding mechanisms and the credibility and visibility of categorical Spinal Cord Injury Systems, we will see an increased involvement in medical management by the SCI Centers. However, realistically and even ideally, the Centers will never achieve complete control over ongoing medical management. This must be compensated by other methods of patient care coordination such as outreach clinics and community based health maintenance programs. Such programs will always be a vital component of a complete Spinal Cord Injury Care System.

A LOOK AT SPINAL CORD INJURY DOWN UNDER

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When an aerogram arrived from Perth in January, 1977, from Sir George Bedbrook, I was both flattered and excited. The aerogram contained an invitation to work in the world famous spinal center in Western Australia for a period of two years. Sir George's writings had not escaped my attention during my residency and faculty years at the University of Washington in Seattle. I first became aware of his views on the management of spinal cord injury while preparing a seminar on the subject. Dr. Donald Gunn, FRCS, who was then Professor of Orthopedics at the University of Washington Harborview Hospital, provided me with several of Dr. Bedbrook's articles and told me of his admiration for the latter.

By May, 1977, my family and I were on our way to Perth, Western Australia, and by June, I had begun working as an attending physician on the Spinal Unit. I was also laying the groundwork for the development of a Department of Rehabilitation Medicine at the Royal Perth Rehabilitation Hospital.

Until the arrival of the invitation, I had ample opportunities in Seattle to follow the course of patients who had been recipients of various surgical procedures, post-spinal trauma. I was intrigued to learn first-hand how patients fared in comparison, who had received no spinal surgery, as this conservative approach was used for the most part in Perth. I also relished the opportunity to see the operation of a truly comprehensive Regional Spinal Cord Injury Center. Since all spinal cord injured patients are referred to this spinal Center, data emanating from Western Australia truly reflects not only the incidence and prevalence of spinal cord injury (SCI), but also the long term results of the rehabilitation efforts, since these are much more easily and closely monitored because of the isolation of the population (1.4 million). A desert separates Perth from the rest of Australia that lies to the east — the Indian Ocean lies to the west.

TOTAL PATIENT MANAGEMENT

I found that the concept of total patient management from day one until day "n" comes quite close to the ideal in most of the Australian Centers. (I had the opportunity to visit all of them at least once.) However, the Center in Western Australia has had for many years now a well organized and functioning system providing optimum services including early rescue, retrieval, and admission to the spinal Center; acute management; rehabilitation and long term follow-up.

*Co-Director.

TEAM CONCEPT

Aside from the advantage of working side by side with Sir George Bedbrook and absorbing some of his extensive knowledge on all phases of management, I saw teamwork at very near its best. By teamwork, I refer to that concept at two levels:

- The *Team* of Medical Specialists who interact with the patient and add their expertise at different junctures. The Team was coordinated under one doctor who maintained entire responsibility for the patient. I shared this latter function with Dr. Bedbrook for one half of the patients. Dr. Ellis Griffiths (now head of the Spinal Unit) and Dr. Nick Batalin handled the other Team.
- The *Team* of Allied Health Professionals were also coordinated by one primary doctor. Each of us directed a Team of allied health professionals who treated the patients on that team.

COMMUNICATION CHANNELS

I also saw the problem of maintaining adequate communication among all professionals involved solved in an effective way. First, Grand Rounds were held every Saturday morning, and every medical specialist attended. The Allied Health Staff were welcome to attend if they wished, and many of them did so. All admissions, as well inpatients and outpatients who developed problems that required the expertise or intervention of one of the specialists, were reviewed, and treatment plans were formulated. Any conflicts arising over the sequencing of the treatment plan were resolved. No one within the multidisciplinary effort was left in the dark — unless he or she failed to show up that Saturday! Secondly, each service held comprehensive rounds once weekly. There were two services — each was composed of one senior and one junior spinal cord consultant and the allied health members. Sir George and I were one Team; Ellis Griffiths and Nick Batalin led the other. The routine management problems were ironed out, and plans for advancement through the rehabilitation effort were made. In addition, the therapists and nursing staff met the first thing each morning and went through each patient's schedule for the day.

What impressed me the most about the allied health professionals, I suppose, was their alertness. They anticipated and responded to each patient's needs appropriately and professionally in a consistent manner.

CONSERVATIVE TREATMENT

I also learned first hand that patients who were managed conservatively by posturing and skeletal traction achieved satisfactory outcomes with respect to alignment and stability. These results showed that surgery is by no means "necessary" in all cases since they could not have done any better than the results achieved. Further, the patient with incomplete lesions were just as likely to show improvement as those I had seen subjected to "decompressive" procedures. In addition, I did not observe the complications and "deconditioning" frequently attributed to six weeks of bed rest. Patients were progressively gotten up with no more difficulty than patients I had previously treated and those who I treat now who were operated upon and gotten up early. A very attractive physiotherapy program, within the prescribed limits, was maintained while the patient was confined to bed.

From studying George Bedbrook's and Byron Kakulas' work on the pathologic changes in man following spinal injury, I realized that spinal injury in man causes significant changes both transversely and longitudinally (at multiple levels) particularly after closed trauma. It also is associated with extradural and intramedullary hemorrhage over an extent far beyond the location of the fracture and/or dislocation. After observing multiple specimens, one eventually realizes that the "Allen Model" used for animal experimentation in no way simulates the violence that causes the changes seen in man; and, efforts to "decompress" the cord in the belief that removing laminae will help this swollen, hemorrhagic structure are bound to be fruitless.

Indications for operative intervention in Western Australia boiled down to basically: *A-Early* which includes failure to reduce a dislocation by closed methods (including manipulation under general anesthesia within the first 36 to 48 hours where indicated); selected penetrating wounds; and, progressive deterioration of neurologic function; unrelated to hypotension and/or hypoxia (This proved to be a very rare event.), or *B-Late* which involves instability as measured by abnormal movement at the fracture site as seen on dynamic films taken three months post-injury (This proved to be necessary in only 5 to 10 percent of the cases.).

CROSS INFECTION CONTROL

Another impressive feature of the system of care evolved in Perth was the pains taken to ensure control of cross infection. Awareness of this aspect of patient management was greater than in any other hospital I have ever visited. I had studied the incidence of bacteriuria in patients undergoing intermittent catheterization in Seattle and was anxious to observe the program of monitoring that was used by John Pearman in Perth. The latter advocated that each catheterization be performed under strict sterile technique including proper surgical draping of the patient and the donning of surgical gown, mask, and gloves by the technician. In spite of these painstaking preparations, however, bacteriuria still occurred, but, at a slightly lower incidence than I had observed previously. All episodes of bacteriuria were promptly treated both while in the hospital and after discharge. The follow-up results (reported by Dr. Pearman in 1977) over a ten year period were remarkable in the lack of complications that I had previously observed and upon returning to the U.S. have come to expect in a spinal cord population.

FOLLOW-UP CARE

While I could dwell on many other points that I feel would interest those caring for spinal cord injured patients, I shall conclude with a further facet of the issue of "follow-up". Plans are begun early after admission to the Spinal Unit to prepare the individual to return to society as a disabled person. Each patient is provided with one wheelchair (free if he has no insurance). He is also eligible for a grant of up to $2500 from the State for home modifications involving structural alterations if he owns or is buying his own home. (This is recouped from third-party settlements, if any, at a later date.) Minor alterations such as the installation of ramps, rails, grab bars, etc. are provided by the Royal Perth Hospital free of charge, regardless of where the patient lives.

VISITING NURSE SERVICES

Two Visiting Nurses attached to the Spinal Unit make regularly scheduled home visits and provide technical and emotional support to the patient and family. These nurses also coordinate Agency Visiting Nurse services with the patients' other needs and abilities. Their availability to patients with problems has resulted in a progressive decrease in readmission to the SCI Unit over the past five years. Having gone out with the Visiting Nurses on scheduled home visits and observed them perform their duties, I am positive that they prevent as many or more problems than they solve. It is from their report that I usually learned if patients were *really* coping after discharge.

SHELTERED LIVING FACILITIES

In every population, there will be some who cannot cope or who find the stress of living as a paralyzed person with limited financial and family supports too overwhelming to devote the time and care that is necessary for the maintenance of health. For such persons, a long-term hospital, "The Quadriplegic Center," is available. Located directly across the street from the Spinal Unit, this Center provides nursing care in pleasant surroundings, which are a cut above what one would expect in a nursing home, by a staff that has undergone continuing education at the Spinal Unit. There is also a hostel for independent persons, contiguous to the "Center", to meet "halfway"

(see Down Under, page 31)

TECHNICAL SERVICE DELIVERY: A NEEDED COMPLEMENT TO THE REHABILITATION TEAM

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What if you were a young college graduate, just beginning your career in a small town in Washington? Then you had an accident which rendered you a quadriplegic. When your physical rehabilitation was complete, could you return home from the hospital without turning your wife or husband into a full-time attendant? Could you drive to work, enter your office, open your mail, dictate messages or answer letters, make phone calls, drive home, and turn on the stereo or TV to relax? Many spinal cord injured people would find this day's activities beyond the realm of possibility. Many of the activities that able-bodied people take for granted are often permanently lost from the repertoire of the spinal cord injured. Yet, the technology is available to allow many people, who are spinal cord injured, to independently perform many tasks such as those described above.

A great amount of effort has gone into the design and production of labor-saving appliances for the able-bodied many of which are also as valuable, if not more so, to the disabled. Other efforts have resulted in a wide variety of assistive systems and devices specifically designed for the disabled. Much of this equipment is currently available off-the-shelf. Yet, these devices have not been made available to a large number of the nation's spinal cord injured—individuals who desperately need such equipment to pursue their independent living goals.

In order for the disabled individual to benefit from the available technology, three basic tasks must be accomplished:

- Health care professionals, counselors and members of the disabled community must become aware of what technology is available; what it can do for them; and how to go about finding it. This step is often an eye-opening one for the disabled person, allowing him/her to expand his/her horizons beyond a small number of often grudgingly-accepted "possible" activities.
- Counselors and other allied professionals need to define tasks they wish to accomplish in terms of available technology; define specific methods to accomplish these tasks; and, allow the disabled person to try out generic types of equipment to determine how it can aid him/her.
- Allied health professionals need to be able to implement these solutions, or have them implemented. This involves identifying funding sources, ordering equipment, making adaptations and training the disabled person in the use of the new equipment.

- A further task could be that of periodically reviewing equipment and needs to afford the disabled person the maximum level of function achievable with the latest technology.

These tasks, which can be grouped under the term "Service Delivery," are evolving at a number of rehabilitation facilities throughout the nation. Tufts University School of Medicine, New England Medical Center, University of Virginia, University of Tennessee Crippled Childrens Hospital, The Institute of Research and Rehabilitation in Texas, Ranchos Los Amigos, Childrens Hospital at Stanford, Craig Hospital in Colorado and New York University are all involved in service delivery projects as are many other Centers. Each of us is dealing with a slightly different set of variables relative to funding sources, referral processes and basic methods of service delivery. Each has received some form of funding which allows it to engage in the process of service delivery. Some are charging for their services, and of these, some are even approximating self-sufficiency as cost centers within their institutions. None of them, however, are operating without some struggle to provide appropriate technology on a fee-for-service basis.

A MODEL FOR SERVICE DELIVERY

At the Department of Rehabilitation Medicine at the University of Washington, we have similarly been involved in developing a model for service delivery. After two years of development under a facilities improvement grant from the Rehabilitation Services Administration in Region X, we have evolved to the point of adding our Engineering Applications Program to the Rehabilitation Team.

This program will provide technical services to a large number of disabled clients at the Center, in conjunction with Physical and Occupational Therapy, Vocational Counseling, Speech Pathology and Prosthetics/Orthotics. This service will be paid for on an established fee-for-service basis, as are the other rehabilitation services. This has not, however, been a trivial task to accomplish, since careful time management is vital, to ensure that the needs of more than just a few clients are met and that the solutions provided are cost-effective.

The initial objectives of the funded project were to establish the facility, disseminate information about the program, and to initiate service delivery. Establishing the facility involved hiring appropriate personnel, developing a method for information retrieval, purchasing equipment for client evaluation, and accumulating a component stock for system modifications.

STAFFING

Three personnel positions were established: an engineer, a technician, and an office assistant. The engineer selected has a background in electromechanical systems; the technician has experience in working with electronic and mechanical materials, along with considerable experience in working with disabled persons. An office assistant was required to maintain the extensive documentation required to fully characterize the methodology for service delivery. We feel that this documentation has provided the key to adequately describe the function of the service and has proved invaluable in evolving the program to the point where it has begun to function on a fee-for-service basis.

INFORMATION RETRIEVAL

Developing a method for information retrieval was considered essential to provide all of the available technology that might apply to a disabled client's needs. Initially, catalogs were collected and filed by the office assistant, whose job it was to organize all the possibly useful information available on equipment and materials. It soon became evident that this included a vast amount of information in a wide variety of areas. Because it would be difficult to handle this in a regular filing system, an information retrieval system was established, using a computer and a file-handling routine. This now allows the user to retrieve information on the product, name of vendor, address, phone number,

date of input, and input number of the file where complete catalog information is available. Any words in the file can be used as "key words" to identify entries and find the appropriate catalog information.

The system—now used extensively within the Center—has grown to the point where it contains over 800 files of information on sources of equipment and materials which may be of use to the disabled population. The system was originally developed to meet needs within the Center, but is now also being used regularly to respond to requests from the community.

EQUIPMENT FOR CLIENT EVALUATION

Maintaining a stock of equipment for client evaluation was also considered an important part of the program. In addition to providing the opportunity to evaluate clients on real equipment, it gives the disabled client a chance to get hands-on experience with a similar system, before their personal system is ordered. This is an especially important step to ensure that the equipment selected will be the most useful or desirable for the disabled person to use.

In order to provide methods to allow people with differing disability levels to operate the types of systems available, it was necessary also to acquire or develop a wide variety of switches and other actuation methods. These allow the selected system(s) to be actuated by almost any movement the person can reliably perform.

A wide variety of components was also acquired, to allow systems to be modified or actuation methods provided to meet individual needs. Because the department has been involved in research and development for many years, the Engineering Applications Program could utilize already-existing facilities, which included several computer systems and fabrication facilities for both electronic and mechanical equipment.

INFORMATION DISSEMINATION

Once the facility and its resources were in place, the next effort of the project was to disseminate information about the capabilities of the program to health science professionals, counselors and the disabled population. This naturally included making presentations to members of medical rehabilitation teams: physiatrists, nurses, therapists, etc. However, it was most important to include vocational agency line staff, especially those from specialized services and centers who will most likely need to know what expectations they can have for their clients. Since these agencies act as "claims evaluators," assessing the value of services in returning their clients to work, it was important to show them the capabilities of the Engineering Applications Program in accomplishing this objective.

IMPLEMENTATION OF SERVICE

Because it was important to demonstrate the effectiveness of the program before establishing a fee-for-service schedule, implementation of the service was begun with the understanding of all agencies that initially there would be no charge for either consultation with the engineering staff or implementation of the recommended system.

The sponsoring agencies, however, were responsible for covering associated medical rehabilitation costs and the cost of the equipment and materials used to provide a solution to an individual's problem. This process was important to the development of the cost center. Before third-party payers could be billed for the service, it was necessary to demonstrate to them that there was a quantifiable benefit in providing the service.

CATEGORIES OF SERVICE

In establishing a service delivery model, it was important to define categories of service to be provided. Three categories were defined as constituting the core of the program: the FEASIBILITY EVALUATION, the TASK EVALUATION and the COMPREHENSIVE EVALUATION.

FEASIBILITY EVALUATION

The FEASIBILITY EVALUATION is designed to familiarize the patient, family, therapist, client, or counselor with the state-of-the-art in systems for the disabled; to learn what types of solutions are available for various problems; and, to allow them to evaluate various kinds of equipment. This consultation is not performed to establish any specific recommendations. Rather, it allows the individual and his/her therapist or counselor to understand what tasks can be accomplished using available systems and devices so that they can develop specific options.

TASK/COMPREHENSIVE EVALUATION

In the TASK EVALUATION, the client, family and team members have defined a specific task or tasks to be accomplished. At this point, specific systems and devices are recommended; and modifications are suggested that will allow the person to accomplish the desired tasks. In the COMPREHENSIVE EVALUATION, the Engineering Applications Program functions as an integral part of the rehabilitation team to arrive at a comprehensive rehabilitation plan. Feasibility and task evaluations are performed as needed to assist in the accomplishment of this goal.

CONSULTATION REQUEST

Whichever type of evaluation is selected, the consultation request from the client's physician is responded to by the Rehabilitation Team Members who best represent the expertise needed to resolve the problem (i.e. ADL problems involve Occupational Therapy; mobility involves Physical Therapy, etc.). Engineering services are never provided without the close collaboration of a therapist or counselor.

IMPLEMENTATION OF SERVICE DELIVERY

The implementation phase of service delivery grows out of the TASK EVALUATION, when the client and his/her family, along with the therapist and other team members, have weighed the relative merits and chances of success in accomplishing the desired tasks. At this point, the engineering staff, in consultation with the clinical staff, specifies a system to compensate for the person's functional limitation. The objective is to provide the simplest, most direct solution with the highest probability of success and continued use. The economics of providing a solution must also be considered and source(s) of funding identified.

Implementation can be achieved either by using off-the-shelf items directly, by modifying off-the-shelf items, or by developing unique systems to meet individual needs. The quickest and least expensive solution usually involves using off-the-shelf equipment, which has been designed to meet specific areas of need. Often, however, off-the-shelf equipment must be adapted or modified to "interface" the client with the equipment so that he/she is able to operate it reliably and achieve the desired outcome. This approach can involve simple adaptations, which are time-effective as well as cost-efficient, or provide solutions which are extremely labor-intensive and costly. Appropriate care must be taken to adequately specify what work will be performed; and accurate time estimates must be made for assembly of the adaptation or modification.

The third alternative is to develop a new system or piece of equipment to meet a patient's unique needs. Since this is by far the most expensive method for implementing a solution, before such a unique project is begun, it is important to search out information on all possible equipment to make sure that no off-the-shelf equipment is available to meet the need, could be modified to meet

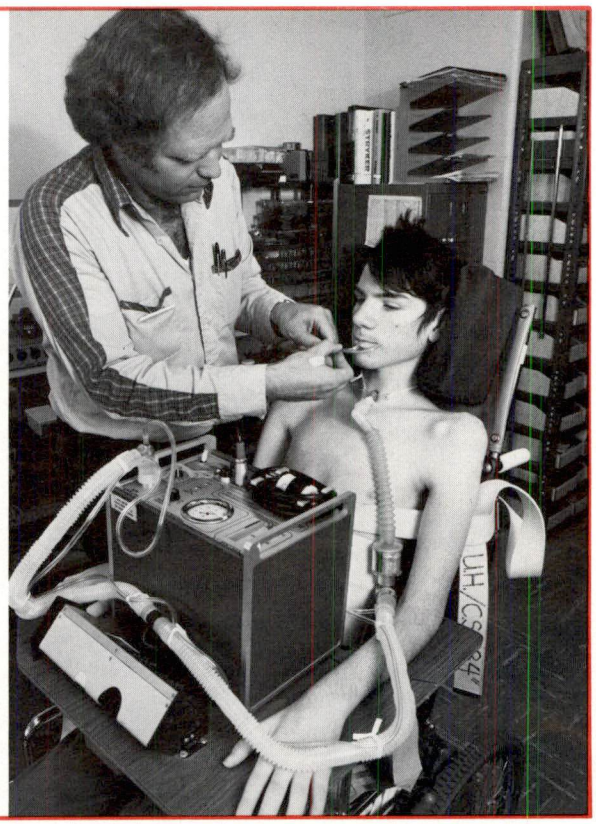
the need, or could meet a slightly modified need. Such a project must be carefully considered before it is proposed, since it requires a high level of expertise in design and in cost estimation if it is to be cost-effective.

Reliability of the design and components is an important factor, since continued troubleshooting at a later date may be a costly consequence of this type of solution. Because of the potential cost of unique solutions, this alternative is often so draining on the entire program that some clients may have to be told that the particular task is not currently possible given the available resources of the program. When such problems are encountered, and especially when they are encountered repeatedly, a need can be identified for research and development to pursue.

CONCLUSION

In the process of providing service delivery, proper allocation of technical staff time is vital for the program to be cost-effective. Very difficult decisions must sometimes be made as to whether a client can be served cost-effectively. But the success of the entire program may depend on these decisions, especially when such programs are subsidized. When a staff concentrates on unique solutions, not only do costs escalate, but the resulting resources drain often precludes serving the needs of a larger number of people who could become more functionally independent with off-the-shelf systems or with systems which require only minor modifications.

Only when an appropriate balance is maintained between all elements of the program can engineering service delivery become a truly viable rehabilitation service. It is then that available technology will be most effectively transferred to the large numbers of spinal cord injured people who need it to live productive lives.



Marvin Soderquist, engineering technician, preparing a recently spinal cord injured person to test drive a powered wheelchair owned by the Engineering Applications Program. In this Task Evaluation, the patient and his therapist have defined mobility as a desired task. Use of equipment owned by the program allows the disabled client and his therapist to determine the feasibility of powered mobility and the specific equipment needed before equipment is purchased. (Engineering Applications Program, University of Washington).

WHEELCHAIR PARACOURSE: ENDURANCE PROGRAM IN SPINAL CORD INJURY REHABILITATION

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Cardiorespiratory fitness, weight control, improved physical and emotional well-being are among the well-publicized benefits of regular physical exercise for the able-bodied population. Little information is available to Physical Therapists describing the needs or benefits of an effective training program for the individual who has lost lower extremity, trunk and even partial upper extremity muscle function. The functioning arm and shoulder girdle musculature must assume a major role in all exercise programs. As in any therapeutic exercise program, individual exercise prescription and management is necessary to achieve the optimal rate of improvement. In this paper, a comprehensive conditioning program for the spinal cord injured individual is described; the rationale for the program's design is explained; and, guidelines for establishing a similar program in other Regional SCI Systems are provided.

RATIONALE FOR PROGRAM DESIGN

In establishing an arm exercise conditioning program for the spinal cord injured paraplegic/quadriplegic patient population, we must first understand able-bodied exercise physiology, training principles, exercise prescriptions and physiological training adaptations. Physical exercise training enables an individual to increase his exercise capacity.[1] Endurance, aerobic work capacity (VO_2 max) and time to attainment of peak heart rate in able-bodied individuals has been shown to increase linearly over a ten-week training period of daily strenuous exercise.[2] A lowered resting heart rate, a lowered heart rate at any submaximal work load, a faster recovery to baseline heart rate and a greater maximum stroke volume have all been observed in response to training.[1] The method of exercise must also be considered, in that the adaptations or effects of training are *specific* to the training methods-adaptations, in each component of the motor pattern trained.[3] Primary changes that occur in trained upper extremity muscles, (i.e., increased oxidative metabolic capacity caused by greater mitochondrial enzymatic activity) may be responsible in part for a decrease in heart rate response to exercise. It is believed that these extra-cardiac factors may result in decreased sympathetic stimulation to the sino-artial node of the heart.[4]

The physiological effects of arm vs. leg exercise have been studied by several groups of investigators. Astrand found that maximum oxygen consumption (VO_2 max) during arm exercise is 70 percent of that for leg exercise. At the same rate of oxygen uptake, arterial blood pressure was

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higher by 20-25mm Hg during upper extremity exercise than during leg exercise.[5] Bar-Or and Zwiren found upper extremity VO_2 max to vary from 53 to 73 percent of the lower extremity VO_2 max among able-bodied subjects. Although they found a continuous progressive all-out arm exercise test to be reliable, they concluded that its validity in predicting maximum aerobic capacity in able-bodied men is only fair.[6]

The training program must be of sufficient *intensity, duration* and *frequency* to achieve the desired training effect.[1] Karvonen showed that a normal subject must work at an intensity of at least 60 percent of his heart rate range for four to five days a week, in sessions lasting thirty minutes a day, to achieve a cardiovascular training effect.[6] This means that a subject with a resting heart rate of 80 beats/minute and a maximum heart rate of 180 beats/minute, has a *heart rate range* of 100 beats, and must work at a minimum rate or:

$$80 + (0.60 \times 100) = 140 \text{ beats/minute}$$

In correlating training heart rate with percentage of maximum oxygen consumption, Davis found that the Karvonen method of calculating training heart rate accurately determined a desired level of exercise intensity.[8] Further evidence exists that optimal training effects require twenty-to-thirty-minute sessions four to five times per week.[1]

CONTINUOUS/INTERVAL TRAINING

Two well-established techniques of exercise training are Continuous Training (CT) and Interval Training (IT). Continuous Training involves sustained exercise at a given intensity for at least twenty minutes. Interval Training requires short periods of intense work alternated with short rest intervals.[1] The two methods have been found to yield little difference in the results of training at an intensity of 70 percent VO_2 max by the CT method and 100 percent VO_2 max by the IT method, in a bicycling program, when the total work load was equated per session.[9]

Physical Therapy, in the treatment of the spinal cord injured patient, traditionally provides the means to prevent joint deformity, to evaluate and selectively strengthen muscles and to achieve a given level of independence in functional activities, such as transfers, bed mobility, balance, standing and ambulation.[10] Physical conditioning beyond these goals is not emphasized in the literature. Few programs require strenuous physical activity beyond resistive strengthening and mat mobility programs. Few provide a model for continuing exercise after discharge. Yet, many of the chronic complications of SCI disability seen at our Center, (such as obesity, osteoporosis, skin breakdown, chronic fatigue, loss of strength and endurance) are merely symptoms of the inactive, sedentary existence of many spinal cord injured individuals.

Evidence indicates that paraplegics can improve their physical work capacity by an arm exercise training program.[11, 12, 13, 14] An arm pedaling training regimen has been shown to significantly improve both cardiovascular functions and body fat composition of normal and disabled sedentary men.[14] Ruosteenja and Karvonen in 1956 studied the response of disabled and normals to arm pedaling a friction Ergometer. They concluded that the disabled had decreased cardiovascular exercise tolerance compared to that of normal controls, in spite of hypertrophy of their arm and shoulder muscles.[15] Similarly, Zwiren and Bar-Or found sedentary paraplegics to be less fit than able-bodied sedentary men. However, they found that the trained wheelchair athlete and the able-bodied athlete had a similar aerobic capacity, indicating that conditioning of the healthy upper limbs and trunk muscles can compensate for the loss of a large lower extremity muscle mass.[16]

PARACOURSE ENDURANCE PROGRAM

A Wheelchair Paracourse Endurance Program for spinal cord injured patients was initiated as an integral part of the rehabilitation process in the Spinal Cord Injury unit of the Physical Therapy Department of Santa Clara Valley Medical Center. The objectives of the program are to improve upper extremity strength and endurance in daily activities through a paced, exercise conditioning

program and to provide patient education by using the program as a model for continuing exercise in the community after discharge from the Regional Spinal Cord Injury System. The major aspects of the program design are summarized in Table 1.

PARTICIPANT ENTRY CRITERIA

The Wheelchair Paracourse Endurance Program involves recently injured patients with quadriplegia and paraplegia, neurological levels C-6 through L-3, including both complete and incomplete spinal cord lesions. Individuals are cleared to begin the Program once spine stability has been achieved, either surgically or through external stabilization. Patients in halo-body casts and other external spinal braces routinely participate in the Paracourse Program. Minimum physical skill criteria — strength, motor skill and balance — are set for the patient to meet before entering the Program. These criteria include functional independence in mat mobility, sitting balance, wheelchair transfers and wheelchair mobility, appropriate to the individual's neurological level of function. These criteria were established to ensure that a patient will be able to safely and successfully participate in the physical demands of the Program.

THE EXERCISE PRESCRIPTION

A target heart rate is set at an intensity of 60 percent of the heart rate range attained during the pre-program exercise test using the Karvonen method,

$$\text{TARGET H. R.} = 60\% \text{ (Maximum H. R. — resting H. R.)} + \text{resting H. R.}$$

THE CONDITIONING PROGRAM

The Wheelchair Paracourse Endurance Program consists of two phases, one using interval training and one using continuous training techniques. Participants are engaged in the program for thirty minutes daily, five days a week for a minimum of 4 to 6 weeks. Each phase of the program is carried out on alternate days. In accordance with the specificity of training theories,[3] and as the means of conditioning, both phases emphasize functional skills used in daily wheelchair activities. This is done to emphasize the practical significance of improved muscle efficiency and endurance to the patient.

The Wheelchair Paracourse. Utilizing the principle of Interval Training, the Paracourse consists of eight exercise stations where high intensity activities of short duration, are done. Activities vary the use of major muscle groups with speed, power, new motor skill and strength. Short rest intervals are scheduled between exercise stations. The quadriplegic and paraplegic patient use the same Paracourse and differ only in those activities requiring hand grip or triceps strength. Adaptations, such as wrist weight cuffs and overhead loops, are used by the quadriplegic when necessary. Exercise starts at a low pace warm-up, peaks at the most strenuous level and levels off in a cool-down phase. The course requires approximately thirty minutes to complete. All equipment used was available in the hospital or Physical Therapy department and the course was planned around the space available in the Physical Therapy Department and adjoining corridors. No additional expense was incurred for commercially available exercise stations, diagrams or unusual exercise equipment. The most extensively used (and readily available) piece of equipment was the participant's own wheelchair.

The Cross Country Wheelchair Jog. Utilizing the principle of Continuous Training, sustained wheelchair movement over a variety of outdoor terrain is used to train the cardiovascular system. The half-mile course includes grass, concrete, ramps, curbs, corners and lateral slopes. The activity is sustained for at least twenty minutes, at a pace adequate to achieve the individual's target heart rate. As physical conditioning improves, the total distance is increased from one to one-and-a-half miles to be covered in the alotted time. (See Table 1)

Table 1. WHEELCHAIR PARACOURSE ENDURANCE PROGRAM*

STATION NO.	PARACOURSE EXERCISES	EQUIPMENT NEEDED	SPACE NEEDED	STAFF RESPONSIBILITY
1	CURLS/SHOULDER FLEXON: Resistive exercise in movement pattern using biceps, anterior and middle deltoid muscles.	QUAD: 3 & 5 lb cuff weights PARA: 8 & 10 lb dumb bells	Easy access to weight cart	Assist Quad patients with cuff weights
2	DOUBLE/SINGLE PULL-UPS: Pull on overhead loops/trapeze to lift buttocks clear of wheelchair rising. 1). Both hands; 2). One hand on trapeze, one on wheelchair tire or armrest.	QUAD: 2 overhead webbing loops. PARA: Overhead trapeze or chinning bar.	Easy access to area; means of overhead suspension.	Assist with height adjustment of bar or loops.
3	50-METER PUSH: Push wheelchair forward in large oval.	Stop watch, and markers as necessary.	50-meter length of corridor w/floor markings.	Start and time each participant.
4	PARA/20-FOOT PARALLEL BAR HANDWALK AND DIPS: With feet supported by therapist in front, patient pushes up on parallel bars to support between bars. "Walks" hands forward specified distance, followed by dip into wheelchair seat and then back up. Another therapist follows patient keeping wheelchair under buttocks.	20-foot adjustable parallel bars. Rolling stool for front therapist.	Access to parallel bars.	Keep wheelchair positioned under patient. Support patient's lower extremities from front.
	QUAD/WHEELCHAIR PUSH-UPS: Patient does specified number of shoulder depressions, lifting buttocks out of wheelchair; places hands on wheelchair tires.	None	Site for wheelchair positioning.	Stabilize for balance if needed.
5	FLOOR TOUCHES: Patient touches hand to floor and returns to sitting, holding weight in hand or on wrist.	QUAD: 3 & 5 lb. cuff weights. PARA: 8 & 10 lb. dumb bells.	Access to weight cart.	Assist Quad patients with cuff weights.
6	DOUBLE FIGURE 8 PUSH: Patient pushes wheelchair forward around a 50-meter course in a figure 8 pattern and then reverses direction and covers same course backwards.	Stop watch and floor markers.	Space for a 50 meter figure 8 course to be negotiated forward and backward.	Start and time participants.
7	WRIST/FOREARM EXERCISE: PARA: Use resistive wrist roll and pronator — supernator for specified time, using following motions (at one repetition/second): Wrist flexon, wrist extension and forearm supernation-pronation.	Wall or table clock; Pronator–Supernator; wrist roll.	Access to apparatus.	Adjust resistance on apparatus.
	QUAD: Performs manually. Resisted wrist extension and pronation — supernation on table top (1 repetition/sec.)	Table top clock.	Access to table.	Provide manual resistance to wrist and forearm motion.
8	25-FOOT DOUBLE CIRCLE: Push wheelchair around 25 x 8 foot rectangle negotiating close turns and maintain good speed.	Stop watch and floor markers.	25 x 8 foot rectangle.	Start and time participants.
	HALF-MILE CROSS COUNTRY WHEEL CHAIR JOG: Push wheelchair over course maintaining an even pace.	Stop watch.	Half-mile circuit with variety of terrain.	Start and time participants. Supervise progress on course.

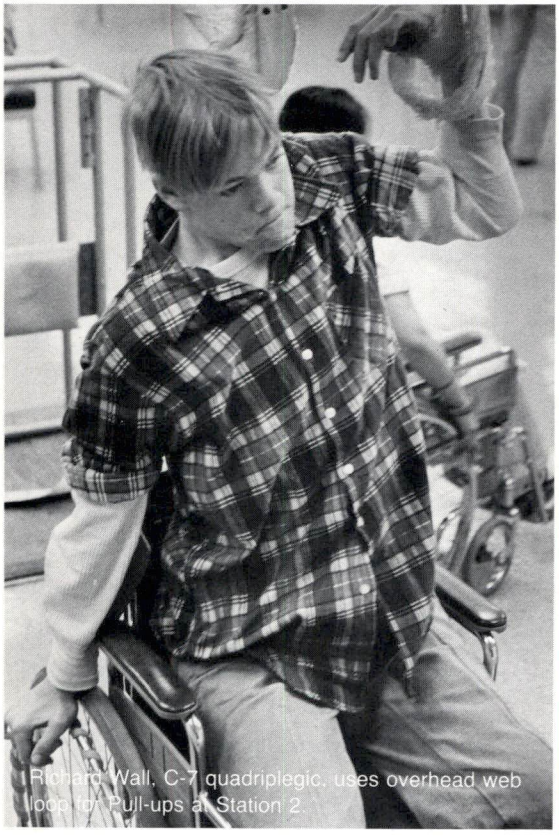
* These are examples of types of exercise stations that can be created using existing space, equipment and personnel.



Tom Rock doing Pull-ups on overhead trapeze at Station 2.



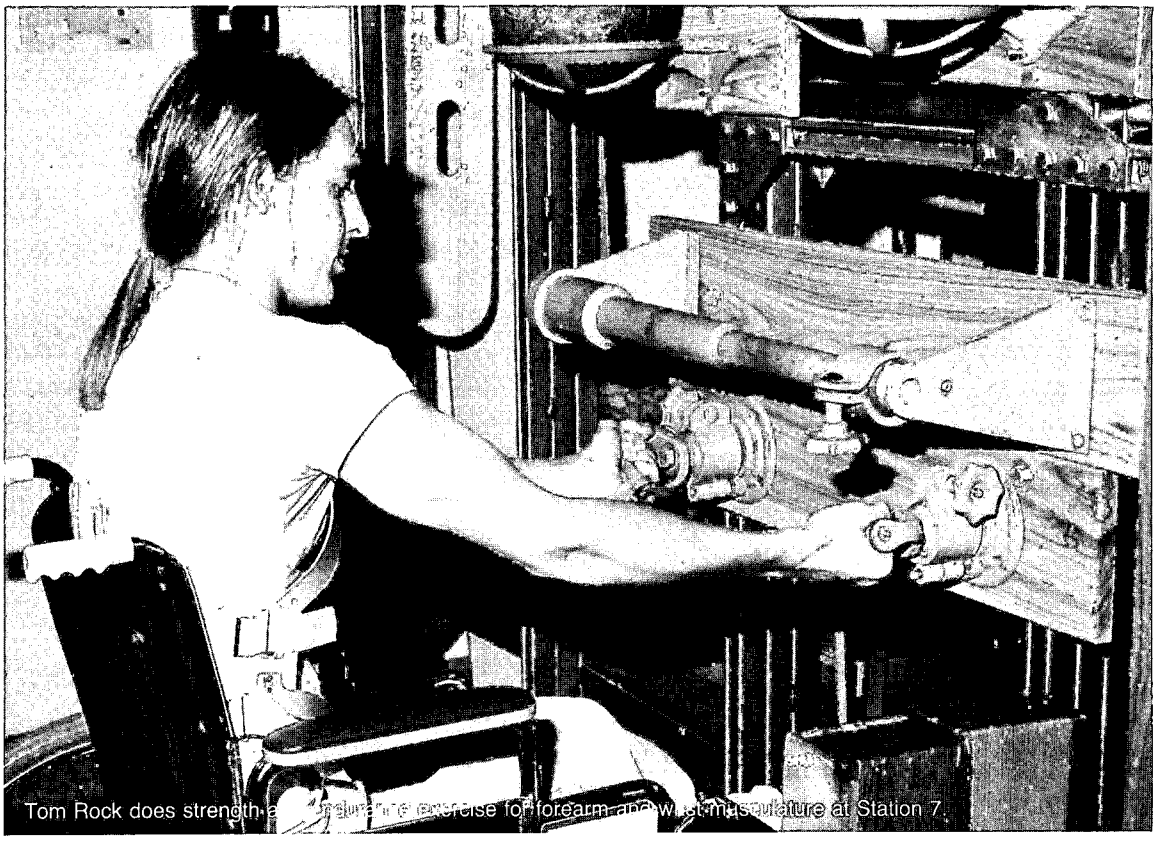
Tom Rock, T-12 paraplegic, performs Curls Shoulder Flexon at Station 1.



Richard Wall, C-7 quadriplegic, uses overhead web loop for Pull-ups at Station 2.



Shantabe Mistry on outdoor Half-mile cross-country Jog Course, which includes a variety of different terrain and slopes at Station 8.



Tom Rock does strength a[illegible] exercise for forearm and wrist musculature at Station 7.



[illegible] paraplegic, performs [illegible] Parallel Bar Hand-Walk at Station 4.

PERFORMANCE EVALUATION AND PROGRESSION

Heart rate response is measured daily at-rest, at mid-course, at course completion and after a two-minute rest period following completion of the Program Paracourse. Participants are encouraged to exercise at a pace which achieves the target heart rate at mid-course and course completion.

Performance levels are graded as Beginning (Stage 1), Intermediate (Stage 2) and Advanced (Stage 3) steps of activity for the quadriplegic and paraplegic patient. The standards were established after the first ten or fifteen patients had completed the program and their skill level and relative improvement was assessed. Through repetitions of an exercise at increased speeds, patients progress from the easier to the more difficult level. Individuals are given immediate feedback as to timed distance and are encouraged during the exercise. Emphasis is placed on competing with oneself, as well as with others of similar neurologic impairment. (See Tables 2, 3)

Table 2. PARAPLEGICS (T-2 to L-3) PAR-COURSE PERFORMANCE LEVELS

	PERFORMANCE LEVELS		
EXERCISE STATIONS	**STAGE 1**	**STAGE 2**	**STAGE 3**
1. Curls/shoulder Flexon (each arm)	8 pounds 10 repetitions	10 pounds 15 repetitions	10 pounds 20 repetitions
2. Pull-ups (double, single, each arm)	10 repetitions 10 repetitions	20 repetitions 20 repetitions	30 repetitions 30 repetitions
3. 50-Meter Push (turns, thru corridor)	40 seconds	35 seconds	25 seconds
4. Parallel Bar Hand-Walk and Dips	10 feet 10 dips	20 feet 10 dips	20 feet 20 dips
5. Floor Touches	8 pounds 10 repetitions	10 pounds 15 repetitions	10 pounds 20 repetitions
6. Double Figure 8 Push (forward/ reverse)	2:45 minutes	2:15 minutes	1:45 minutes
7. Wrist/Forearm Supination-pronation	30 seconds	30 seconds	1 minute
Wrist Ext. (supination)	30 seconds	30 seconds	1 minute
Wrist Flex. (supination)	30 seconds	30 seconds	1 minute
Wrist Ext. (pronation)	not done	30 seconds	1 minute
Wrist Flex. (pronation)	not done	30 seconds	1 minute
8. Double circle (25 x 8 feet)	35 seconds	30 seconds	25 seconds
Half-mile cross-country jog.	20 minutes	12 minutes	9 minutes

Note: The above are meant to serve only as general guidelines for exercise progression. Standards must be set, for timed distances, by the length and degree of difficulty of each individual course.

Daily documentation includes the individual's performance level in each activity, as well as the resting and exercise heart rates. Individual charts are kept, as well as a large group display in the exercise area. Patients receive initial and on-going education about the training process, their exercise prescription goals, expected physiologic adaptations and the importance of continuing activities, such as wheelchair jogging, after discharge.

DISCUSSION

We have found this vigorous, functional, cost-efficient conditioning program to be an asset to our existing Spinal Cord Injury Rehabilitation Program as well as a simple model for continuing exercise and self-performance evaluation in the community after discharge. Physical Therapists have the skills and knowledge to lead future program development in this area.

Table 3. QUADRIPLEGICS (C-6 to T-1) PAR-COURSE PERFORMANCE LEVELS

EXERCISE STATIONS	PERFORMANCE LEVELS		
	STAGE 1	STAGE 2	STAGE 3
1. Shoulder Flexion (with cuffs)	3 pounds 10 repetitions	5 pounds 10 repetitions	5 pounds 20 repetitions
2. Pull-ups (overhead web loops)			
double	10 repetitions	20 repetitions	30 repetitions
single, each arm	10 repetitions	20 repetitions	30 repetitions
4. Wheelchair Push-ups	10 repetitions	15 repetitions	20 repetitions
5. Floor Touches (cuff weights)	3 pounds 10 repetitions	5 pounds 10 repetitions	5 pounds 20 repetitions
6. Double Figure 8 Push	6:30 minutes	5:00 minutes	3:30 minutes
7. Wrist Extension (manual resistance, 1 repetition/second)	30 seconds	45 seconds	1 minute
8. Double Circle (25 x 8 feet)	60 seconds	50 seconds	40 seconds
Half-mile cross-country wheelchair jog	30 minutes	25 minutes	20 minutes

Note: The above are meant to serve only as general guidelines for exercise progression. Standards must be set, for timed distances, by the length and degree of difficulty of each individual course.

The value of this fitness program, both immediate and long-term needs further controlled study and documentation, including the development of a valid clinical evaluation tool to measure conditioning levels for the neurological levels of disability following spinal cord injury. Daily continuing exercise and active participation in sports and leisure time activities may be essential prophylaxis for the medical/physical complications encountered by spinal cord injured. Research will further define the needs for the benefits of continuing vigorous wheelchair exercise for this patient population. Rehabilitation members must realize that traditional programs for the treatment of spinal cord injury fall short in this area.

SUMMARY

Previous studies have shown that paraplegics can increase their physical work capacity by an arm exercise training program.[11, 12, 13, 14] A group wheelchair exercise and conditioning program, consisting of a WHEELCHAIR PARACOURSE and a CROSS-COUNTRY WHEELCHAIR JOG, was developed for spinal cord injured. The program was established as an adjunct to traditional strengthening, pre-ambulation activities, wheelchair mobility and endurance training. A pre-program evaluation was done, using a progressive arm-crank exercise test to measure response to exercises, physical work capacity and to prescribe a training heart rate for the four-to six week exercise period. The program has been an asset to the existing spinal cord injury Physical Therapy Program at the Northern California Regional Spinal Injury System, as we have found it to be cost-efficient, functional and a simple model for patient education.

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Down Under . . .

(continued from page 17)

needs. This also has a sheltered work shop which provides vocational outlets for those who wish to work but cannot obtain employment in the open market. All facilities are wheelchair accessible, and all employees are treated with dignity and respect — something that is sometimes lacking in, or overlooked by, employers in the open market in all countries.

CONCLUSION

In conclusion, I can only say that the system of care for the spinal cord injured patients that I saw in Western Australia was superb.

After I really got to know Sir George Bedbrook, I became aware that the system in Perth is nothing more than a reflection of his own foresight, dynamic personality, hard work, clinical acumen, and leadership qualities that have resulted in the generation of an "esprit de corps" that makes all who work in that unit want to do their best for the patient, for the hospital, and for their leader. I have yet to meet anyone who I respect more than Sir George Bedbrook.

PROGRAM EVALUATION AND FOLLOW-UP

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Post rehabilitation follow-up monitoring activities have been carried out in several comprehensive medical rehabilitation facilities during the last decade. In general, however, these activities have occurred in conjunction with research and evaluation studies and were focused primarily on specific target populations or on efficacy of experimental treatment procedures. Often, such data are not formally incorporated into treatment protocol on completion of the study — results are often found in journals many years later. Continuous and systematic post treatment monitoring related to the various rehabilitation programs that are aimed at facilitating community re-entry is rarely found. Therefore, timely and ongoing feedback is quite often lacking.

PROGRAM EVALUATION AND FOLLOW-UP SYSTEM

In compliance with the Commission of Accreditation of Rehabilitation Facilities (CARF) Guidelines, a formal Program Evaluation and Follow-Up system (PEFU) was initiated at the Rehabilitation Institute of Chicago (RIC) in February, 1979. The objectives of the Program Evaluation and Follow-Up system include:

- Assessment of RIC treatment program effectiveness and efficiency.
- Assessment of individuals levels of retention of skills acquired during rehabilitation.
- Provision of prompt medical, functional, or psycho-social intervention when necessary.

The PEFU system is based on eleven patient care goals which reflect results that the staff are expected to achieve with inpatients. Among these goals are: *minimize preventable medical complications* (e.g. pressure sores, burns, kidney damage and pneumonia); *acquire, maintain and utilize mobility skills* (e.g. wheelchair and transfer skills); and, *maximize vocational independence* (e.g. employment, school or other vocational training).

DATA COLLECTION QUESTIONNAIRE

A telephone data collection questionnaire is the main patient monitoring tool of the PEFU system. The instrument, based on the aforementioned goals, was developed from questionnaire items used in previous research projects, as well as suggestions from the clinical and medical staff. Designed to measure each patient's status medically, functionally, psycho-socially and vocationally, the

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questionnaire assesses what the patient is actually doing within his/her community and home environments. The instrument has several sections on re-hospitalization, medical complications, mobility, home management, communication and self-care skills, leisure time activities, vocational independence, and resources received or needed.

The questionnaire is administered over the phone to patients in all diagnostic categories (i.e., spinal cord injury or disease, stroke, traumatic brain damage, amputation, cerebral palsy, burn, fracture and progressive disorders) on three physician's services at one, three, six and twelve month intervals after the patient is discharged or discontinues outpatient therapy programs at RIC. If, at the time of the interview, a need for intervention or referral is perceived, the patient's physician is contacted to ensure appropriate follow-up action.

COMPUTERIZED INFORMATION SYSTEM

Presently, data from 124 and 60 interviews at one and three months, respectively, have been entered in the RIC Computerized Information System (REHABIS) (Harasymiw, Stahl, 1978). Outcome information with regard to each patient's medical, functional and vocational status at the time of follow-up will be reported in this paper for 15 spinal cord injured (SCI) paraplegics (paras) and 24 SCI quadriplegics (quads) at one-month post-discharge, plus seven SCI paras and 16 SCI quads at three-months post-discharge. All SCI's were secondary to trauma. The sample consists of 18 first admissions to RIC, and 21 readmissions to RIC for the one-month group. For the three-month group, nine are first admissions to RIC and 14 are readmissions.

While an attempt was made to contact each patient at one and three months, not all patients were available, therefore, some subjects included in this sample were not interviewed at both time periods. Since the sample size is small, the data can only be considered as preliminary at this time. However the results do serve as an indication of trends in patient status over time.

At one-month post-discharge, 96 percent of both the paras and quads had not developed medical complications since discharge (i.e. pressure sores, burns, kidney damage, and pneumonia). At three-months post-discharge, 93 percent of the paras and 92 percent of the quads reported *no* medical complications since discharge. The reporting of pressure sores and burns was based on actual observation by the patient, while kidney damage and pneumonia was based on whether a physician had informed them of such. While it appears that only a small percentage of patients develop medical complications after discharge, it will be important to continue monitoring this variable to determine whether patients develop medical complications the longer they are away from direct, day-to-day medical supervision.

PATIENT STATUS: SELF-CARE SKILLS

Patient status in the area of self-care skills (i.e. feeding, undressing, and bladder care) are given in Table 1. The level of independence in self-care skills apparently remains stable for the quads but improves for the paras, except in the area of bladder care. A slight decrease in bladder care independence may be due to a variety of causes. For instance, patients may find it easier or less time consuming, to receive assistance at home in their bladder management. This variable can be tracked to determine if this is a trend which continues, and if so, what can be done to help patients maintain independence as time after discharge increases. As would be expected due to greater functional abilities, the paras do better than the quads in all self-care skills.

PATIENT STATUS: MOBILITY SKILLS

Patient status for mobility skills (i.e. outdoor and indoor mobility and transferring in-and-out of a car) are presented in Table 2.

Table 1. SELF-CARE SKILL LEVELS OF PARAS AND QUADS AT ONE AND THREE MONTH FOLLOW-UP

SELF-CARE SKILL	ASSIST. NEEDED*	FOLLOW-UP											
		One-Month						Three-Months					
		Para		Quad		Total		Para		Quad		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
Feed Self	Independent	15	100	14	61	29	76	7	100	10	63	17	74
	Support	0	0	8	35	8	21	0	0	6	37	6	26
	Dependent	0	0	1	4	1	3	0	0	0	0	0	0
Undress:													
Upper Body	Independent	11	73	3	13	14	36	7	100	3	19	10	43
	Support	4	27	19	80	23	59	0	0	12	75	12	52
	Dependent	0	0	2	7	2	5	0	0	1	6	1	5
Lower Body	Independent	10	66	3	13	13	34	7	100	2	13	9	39
	Support	5	33	17	71	22	56	0	0	13	81	13	56
	Dependent	0	0	4	16	4	10	0	0	1	6	1	5
Bladder Care	Independent	12	80	3	13	15	39	5	71	1	6	6	26
	Dependent†	3	20	21	87	24	61	2	29	15	94	17	74

* Independent—Performs activity without assistance
Support—Performs activity with physical assistance, supervision, equipment or set-up.
Dependent—Cannot perform activity even with assistance of equipment or human aid.
† Dependent—Requires moderate degree of help or cannot do without human aid.

The data indicate there may be a trend toward increasing independence in mobility skills over time, particularly for the paras, While it is unclear why patients show greater overall improvement in mobility skills compared to self-care skills, it could be surmised that a peak level of functioning is reached in self-care while the patient is in the hospital. Therapists and nurses at RIC concentrate on the teaching self-care. These skills are easily transferable to the home. While mobility skills are also emphasized, the application of these skills may require further practice within the home environment. In addition, RIC is completely accessible while most patient's must alter their environment for optimum mobility. The increase of independence in mobility could thus be seen as a result of patients learning to apply their skills in a new environment.

Table 2. MOBILITY SKILL LEVELS OF PARAS AND QUADS AT ONE AND THREE MONTHS FOLLOW-UP

MOBILITY SKILL	ASSIST. NEEDED*	FOLLOW-UP											
		One-Month						Three-Months					
		Para		Quad		Total		Para		Quad		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
Get around Outdoors	Independent	3	21	2	9	5	14	4	57	2	13	6	26
	Support	11	78	20	91	31	86	3	43	14	87	17	74
	Dependent	0	0	0	0	0	0	0	0	0	0	0	0
Get around Indoors	Independent	4	29	4	17	8	22	4	57	4	25	8	35
	Support	10	71	19	83	29	78	3	43	12	75	15	65
	Dependent	0	0	0	0	0	0	0	0	0	0	0	0
Transfer in and out of car	Independent	10	67	2	8	12	31	7	100	5	31	12	52
	Support	5	33	20	82	25	64	0	0	11	69	11	48
	Dependent	0	0	2	8	2	5	0	0	0	0	0	0

* Independent—Performs activity without assistance
Support—Performs activity with physical assistance, supervision, equipment or set-up.
Dependent—Cannot perform activity even with assistive equipment or human aid.

VOCATIONAL STATUS

In the area of vocational independence (see Table 3), the percentage of patients who have attended school, or received training, since discharge is greater than the percentage who have been employed since discharge. It could be surmised that returning to school is easier at one and three months post-discharge than entering or returning to work. Although it is not known how many patients in this sample will be employed in the future, the low number of patients employed serves to illustrate the continued need for employer and societal education, and acceptance of the spinal cord injured person.

Table 3. VOCATIONAL STATUS OF PARAS AND QUADS ONE AND THREE MONTHS FOLLOW-UP

VOCATIONAL		FOLLOW-UP											
		One-Month						Three-Months					
CATEGORY	STATUS	Para		Quad		Total		Para		Quad		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
Employed since discharge	Yes	2	13	0	0	2	5	1	17	1	7	2	10
	No	13	87	23	100	36	95	5	83	14	93	19	90
Attended school or received training since discharge	Yes	1	7	6	25	7	18	2	33	5	31	7	32
	No	14	93	18	75	32	82	4	67	11	69	15	68

SUMMARY

The data presented herein are a preliminary look at the trends in patient status after discharge. Programs are meaningless if skills learned prior to discharge are not applied in the day-to-day routine of patients once they return to the community. The information received from the questionnaire is useful as applied to each individual patient in order to alert the physician to potential problems and to assist in the identification of high-risk patients. It also presents the opportunity to identify aggregrate patient strengths and weaknesses after discharge which can be used to make adjustments in patient care programs to help optimize patient independence *after* they leave the hospital.

TOWARD MAKING GROUP TREATMENT MORE EFFECTIVE

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Group treatment is often considered as a means of improving the cost effectiveness in running a therapy department. But, the patient must benefit from, and be satisfied with, group treatment or the program can not be considered a viable method for achieving cost effectiveness in department operations.

One recognized problem is that frequently patient-therapist communication breaks down and the patient becomes dissatisfied with therapy services. Usually, both patient and therapist begin these group sessions in full agreement on what the patient is realistically expected to gain from participation in group therapy. But, this does not last unless effective communication is maintained between the patient, his/her therapist, and the personnel conducting the group sessions. Furthermore, patients are sometimes placed in group therapy before a thorough evaluation has been made to determine their potential for benefiting from such group sessions.

The material presented herein serves a twofold purpose:

- Demonstrate the process the Occupational Therapy (OT) Department, Santa Clara Valley Medical Center, went through to turn an ineffective group program into a viable, productive one.
- Describe the revised Occupational Therapy Group Program in sufficient detail that the procedures can be used by other OT Department interested in developing similar groups.

We have found that by establishing and maintaining a minimum standard of communication between the patient, therapist and group leader that an assistant can deliver individualized treatment to approximately six patients simultaneously rather than just "conducting a group" session.

The Occupational Therapy Department, at the Santa Clara Valley Medical Center, has had a daily therapy group for the purpose of improving the hand skills of their quadriplegics patients, on an intermittent basis, for several years. This group has had many of the problems common to group treatment. Each time a group was started, the staff was enthusiastic and supportive, communication was good and patient attendance was regular. Gradually, however, patients would begin to complain to other patients and staff that the group therapy was boring, childish, and not worth their time,

* Occupational Therapy Supervision

etc. The Certified Occupational Therapy Assistant (COTA) conducting the group would become frustrated and, alternately, attempt to improve the situation by recruiting new patients on her own or avoid the situation by finding reasons to cancel the group sessions. In May 1980, the Occupational Therapy Department again tried to determine how to improve and maintain the quality of this program.

Apparently, everything had been tried. The number of staff for the group had been increased, the number of patients had been decreased. The staff level had been changed from technical to professional and back to technical again. The group schedule had been changed, the type of functional activities had been revised. The referral system had been revamped and new equipment purchased. The Staff had been reminded over and over not to "dump" patients in the group. None of these changes had any lasting impact. Accordingly, we decided to discontinue the group and re-evaluate the situation.

Obviously, the real problem had not yet been identified. Discussion with the COTA indicated that she had not been receiving sufficient information from the referring therapists. She lacked specific goals for some patients and treatment implementation suggestions on almost all of them. She had been attempting to determine the modalities and implement treatment on up to six patients during the group session. She had tried to make them all happy and facilitate group processes as well. Discussion with the therapists revealed several things:

- They did not know what clinical information would be meaningful to the COTA.
- Sometimes the therapist had not completed the evaluation prior to placing patient in the OT Group.
- The therapists repeatedly recommended the same modalities for their patients' goals.

The problem appeared to be lack of communication between the therapist and COTA as well as between the patient and therapist. This resulted in patients being placed in the group with almost no follow-up and not fully realizing why they were in the group in the first place.

The solution seemed to be twofold. First, identify which people needed to communicate what information to whom, by what time, how often, and by what method. Second, a system was needed to ensure ongoing communication with all concerned for the group to exist as an effective therapy process.

The identification process started with all sorts of lists: What therapists needed to know about their patients? What kind of goals could realistically be addressed in a group setting? What responsibilities the assistant had to each referring therapist? What the patient needed to know, etc? Out of these lists, drafts were developed for a procedure including policies, referral forms, progress note forms and therapist feedback forms. These drafts were presented to the OT Staff for their revision and ratification. Each item was carefully considered for necessity, clarity, implications, spacing, etc. By the end of an hour, the Staff agreed to the proposed program and the plan to restart the group in two weeks.

Several important changes occurred during this process of ratification. The role of the COTA and referring therapist changed significantly from what it had been previously. All referring therapists are now intimately involved in establishing and maintaining specific individual goals for their patients and the modalities to be used in the group. The COTA is now delivering individualized treatment for approximately six patients simultaneously rather than "conducting a group." The responsibility for patient progress and attendance is now distributed between patient, therapist and COTA. In addition, the purpose of the group was re-defined and the name was changed.

The group was restarted in June with strict adherance to the agreed upon procedures—each Staff member received a copy for reference purposes. (See Figure 1). The group advisor required that the COTA demand complete and appropriate referrals. Five out of the first six referrals were

Figure 1. OT GROUP POLICY*

1. PURPOSE OF GROUP: Provide a group situation that allows patients to practice upper extremity functional activities so that they increase their speed, co-ordination, endurance and naturalness in using their upper extremities.
2. FORMAT: One-hour daily sessions, conducted by an assigned COTA. Program consists of three to six patients working on individual functional activities.
3. PREREQUISITES—THERAPIST MUST:
   a. Complete a referral form for the patient.
   b. Establish mutually agreed on goals and functional activities with patient.
   c. Select goals that can be met in a group situation.
   d. Have patient successfully perform all activities with prescribed set-up prior to joining in OT Group activities.
   e. Provide half an hour of muscle re-education daily if patient has an incomplete injury involving hand muscles.
4. REQUIREMENTS FOR CONTINUED PARTICIPATION:
   a. Therapist 1) Return group response forms weekly.
      2) Keep COTA in charge of group abreast of significant changes in patients' clinical/ psycho-social picture.
   b. Patient 1) Make progress.
      2) Attend group regularly and on-time.
      3) Behave appropriately in the group.
5. TIME LINES:
   a. New referrals—therapist completes patient referral form and places in COTA's mailbox by 4:30 pm each Thursday for patient to join the group the following Monday.
   b. Progress notes—COTA completes Progress Report for each patient and places in therapist's mailbox by 4:30 pm each Thursday.
   c. Therapist response forms—therapist completes response form for each patient and returns to COTA's mailbox by 3:30 pm each Friday.
6. GROUP STAFF RESPONSIBILITIES:
   a. COTA—Runs group each day.
      Screens referrals for completeness.
      Writes progress notes.
      Maintains a waiting list when group is full.
      Evaluates potential group members with group advisor to determine which ones could benefit the most from the OT Group sessions.
   b. Group Advisor—SCI therapist designated to act as a resource to group COTA on a prn basis.

* Occupational Therapy Department, Santa Clara Valley Medical Center

returned to the therapists, including the Service Supervisor, for further information and clarification. The Supervisor backed up the COTA by quickly revising and resubmitting her referral and having her staff do likewise. There was a great temptation to start making exceptions in the procedure. Exceptions were *not* made—but all suggestions were recorded so that the policy and forms could be revised after a three-week trial if that was found to be necessary or desireable.

The only resemblance the present "Occupational Therapy Group" bears to the old "Hand Group" is that it is held at the same time and place and with the same staff. The group now has a waiting list. Patients show up on-time and attendance is no longer an issue. If a patient misses several

sessions, the usefulness of the group for this patient is seriously examined by the referring therapist and the patient—changes may be made accordingly. An increase in the variety of functional activities utilized in the group was noticeable as each therapist and patient determined together what activities will meet the patient's personal goals. This increased variety of activities has made the group more interesting to both patients and staff. The Occupational Therapy Group is now the highpoint of the COTA's job responsibilities.

The Occupational Therapy Group now functions effectively as a result of requiring that:

- The therapist thoroughly assess the patient's ability to benefit from the OT Group.
- The patient knows why he/she is in the Group and wants to be there.
- The therapist and assistant stay in continuous communication.

By requiring appropriate communication between the therapist and the COTA, an effective program was produced that resulted in more effective use of staff and reduced health care cost.

ACKNOWLEDGEMENT

The author would like to acknowledge the contribution of Chris Spinella, COTA to the development of the "OT Group."

Please Note . . .
Sample copies of the OT Group Referral and Progress Note/Therapist Response (required on a weekly basis) Forms are available on request from the Occupational Therapy Department, Santa Clara Valley Medical Center, San Jose, California.

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Birmingham, Alabama

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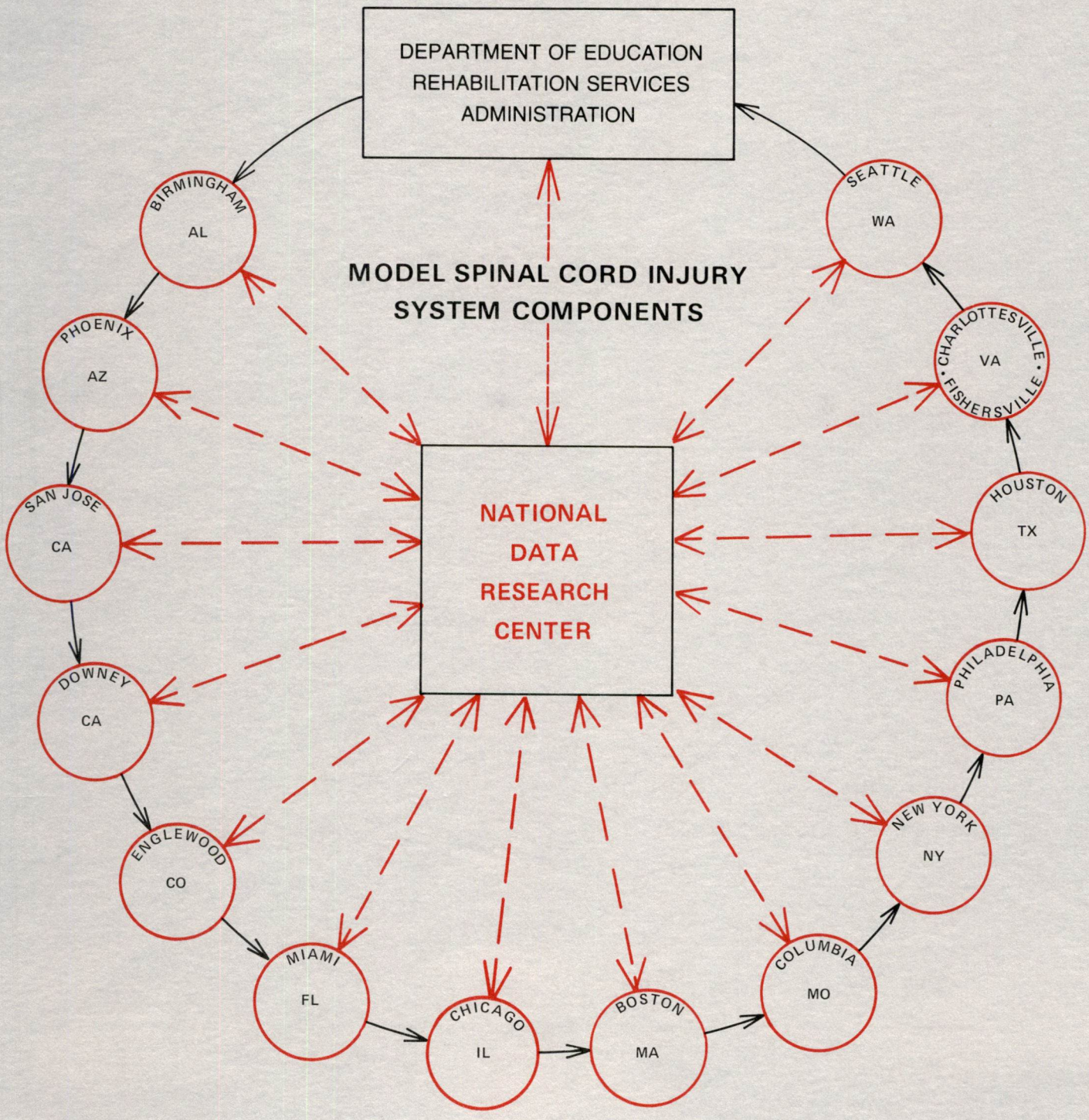
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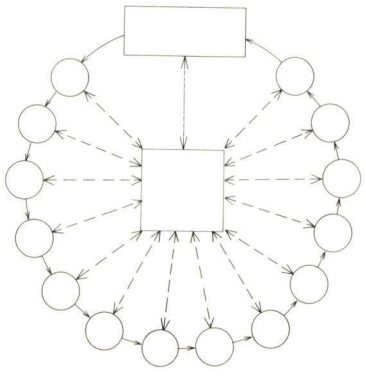
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FRONT COVER: *This schematic diagram is symbolic of the functional interrelationships between the Regional Model Spinal Cord Injury (SCI) Systems, the National SCI Data Research Center and the U.S. Department of Education, Rehabilitation Services Administration.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

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FROM THE DATA BANK . . .

Progress and Problems



John S. Young, MD

The concept of a continuity of care for the spinal cord injured from the moment of injury through the initial medical-rehabilitation period and on into an on-going program of health maintenance has made tremendous advances toward the ability of the spinal cord injured to survive their injuries and live meaningful and successful lives. However, as with all progress, advances in spinal cord injury care have created additional problems. Survival following spinal cord injury has become routine rather than rare, this includes not only the paraplegics but also the quadriplegics, and more recently, even the "high quads".

As Emergency Medical Services and Trauma Centers have become more sophisticated in initial evacuation and treatment and as the medical-rehabilitation team in specialized spinal cord injury centers becomes more proficient, a greater number of high level quadriplegics are surviving their initial injury. Fortunately, most of them regain enough neurological function to become independent of respiratory assistance. However, at least twenty percent will need major assistance from others for most of their daily living activities. Their rehabilitation needs require extraordinary skills and understanding from the rehabilitation team. The high initial cost of care combined with ongoing medical and social costs makes this a catastrophic injury not only for the injured individual and his family but also for society which, in one way or the other, must pay the bill. It is estimated that the United States is experiencing approximately 8,000 new spinal cord injuries among its population per year. As indicated elsewhere in this issue about 16 percent of these are high quadriplegics of which at least 80 percent have severe permanent paralysis. The initial medical-rehabilitation expenses for the "high quad" average about $60,000. Preliminary data suggests that recurring expenses for continued medical and social costs may average between $10,000-$20,000 annually.

These are sobering figures. The question can be raised: Is it worth it? This is a philosophical question that medicine cannot answer. It must be remembered that the spinal cord injured retain all of their faculties that make them human. They are primarily young people with clear minds and youthful aspiration. They are loved and have loved-ones. Professionals responsible for their initial care are continually amazed to see most of them accommodate to their disabilities and continue to lead meaningful lives. Some recover a major proportion of

(continued on page 55)

INTEGRATION OF SPINAL CORD INJURY AND EMERGENCY MEDICAL SERVICES SYSTEM PLANNING

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The Emergency Medical Services Systems Act (EMSS) was initially passed in 1973 and amended, as Public Law 94-573, in 1976. The Act provides the mechanism and funding necessary for communities to develop regional Emergency Medical Service (EMS) delivery systems. To oversee and assist in the development of EMS entities, the Act instructed the Secretary, Department of Health, Education and Welfare (DHEW), to designate a federal lead agency. Accordingly, the Division of Emergency Medical Services (DEMS) was created within DHEW.



James T. O'Heir

Included in the basic EMSS Act are 15 components which must be provided in each EMS regional plan. Spinal cord injury (SCI) is one of seven categories in the Critical Care Component.

In planning the strategy for the development of "wall-to-wall" EMS Systems within the contiguous United States, DEMS identified 304 geographical regions. Each of these regions will, theoretically, develop an EMS plan to meet the particular regional needs that will comply with the criteria of the Emergency Medical Services Systems Act and the administrative policies developed by DEMS. Included in the criteria for the Critical Care Component is the selection of a SCI Consultant and the designation of a Spinal Cord Injury Center. In the Critical Care Component, the federal criteria *does not* require that these specialty care centers be physically located within the individual EMS regions, only that a treatment plan for those patients be developed.



Newton C. McCollough, III, MD

From the experience of the past decade, EMS has conceptualized three models based on professional and fa-

*EMS Director
†Project Director

cility availability plus geographical considerations. These models have been described and publicized in several journals and at a number of national EMS seminars. These conceptualizations are:

- "X" Model which is an Urban/Suburban configuration.
- "Y" Model which is a Rural/Metropolitan configuration.
- "Y^1" Model which is a Wilderness conceptualization.

Each of the 304 EMS regions falls into one of these three categories.

This brief synopsis of the Federal plan for EMS System development reflects the thinking of knowledgeable professional personnel who have produced a viable plan for the development of EMS Systems. Despite objections from various medical and hospital associations (HSA's, etc.) that these concepts are "all right for other regions, but our region is unique," the overall plan has withstood the test of time and proven to be an effective design for the delivery of emergency medical care.

Concurrently with the development of EMS, the Rehabilitative Services Administration has been concentrating on a design for SCI Systems. Currently, 14 Regional Spinal Cord Injury Systems are operational across the United States, each with a defined geographical "catchment" area. These defined areas may include a number of recognized EMS regions. Obviously, with only 14 Regional SCI Systems, many of the 304 EMS regions are not serviced by a federally designated SCI Center. The total SCI Center need of the country has not been officially determined, however, 70 Centers is the figure usually discussed by national SCI leaders. This figure is also endorsed by the EMS leadership. Each applicant for designation as a Model Systems' Spinal Cord Injury Center is required to indicate its involvement with EMS planning. This involvement, however, is all too frequently limited to the immediate locale of a Center and does not encompass the entire catchment area.

The generally accepted annual SCI incidence rate is 35 per million population. The updated 1977 census indicated a national population of 216,332,000. Thus, SCI planners could anticipate 6,180 victims annually. This would average 88 patients for each of the seventy proposed SCI Centers if they were distributed throughout the nation on a population and incidence rate basis.

It is interesting to note that many of the 304 EMS regions do not have a population of one million—particularly those regions conceptualized as "Y^1" and many of those designated as "Y" regions. This indicates that, within these regions, patient exposure for clinicians, nursing and rehabilitative personnel is insufficient to gain or maintain expertise in SCI management. Unfortunately, because of ego, "turf" and parochialism, many EMS planners have chosen to interpret the Federal EMS Guidelines as meaning that each region must be independent in all aspects of emergency care system planning. Consequently, EMS regions with minimal populations have designated physicians as SCI Consultants and hospitals as SCI Centers, neither of which has managed a SCI victim in years. This author recalls reviewing an EMS proposal in which one bed in a Regional Trauma Center had been designated as the SCI Center and a General Surgeon as the SCI Consultant. The Regional Trauma Center, incidentally, was within 160 air miles of a Model Systems' SCI Center and emergency helicopter evacuation was available with a thirty-minute response time.

In view of the above, it becomes incumbent upon Model Spinal Cord Injury System physicians and planners to reach out beyond their immediate and existing service areas, contact EMS System physician directors and planners, and become actively involved in the formulation of all EMS proposals. Unless the individual EMS region has a potential SCI incidence rate sufficient to justify development of a total capability SCI Center, we must develop macro-regional EMS/SCI Systems whereby the SCI Center in one EMS region cooperates with surrounding EMS regions in delivering specialized critical care. This collaboration should go beyond merely accepting the SCI victim but, to be totally effective, must also involve the planning of SCI training programs for both pre-hospital

and emergency department personnel as well as development of standard treatment and transfer protocols. This macro-region concept must, if necessary, override any territorial boundaries such as state borders, HSA regions, etc.

In planning and developing training programs for emergency care providers, particular attention should be directed toward the assessment of the possible spinal cord injury victim. Unfortunately, the majority of the training programs available to pre-hospital care personnel provide minimal guidance for a systematic neurological assessment. For this reason, many SCI victims are not immediately identified and are often delivered to facilities not staffed or trained in acute SCI stabilization.

Involvement in training programs is mutually beneficial to the SCI System and the EMS program. Obviously, the EMS System benefits from the expertise of the SCI professional. Concurrently, the SCI System personnel have an opportunity to voice their opinions as to facility designation and gain access to logistical support normally available in the EMS network—such as primary and secondary transport capability. It would be totally unnecessary, for instance, for the SCI network to develop a helicopter service for patient retrieval when this capability exists in the EMS System.

Each EMS System is required to develop a "patient tracking system". This assists EMS System planners and developers in defining the critical care needs of their region and identifying those facilities that are routinely receiving critically injured victims. Furthermore, this system permits the planners to determine why a patient is treated at one facility in lieu of another. Finally, through this mechanism, EMS planners can monitor "compliance" with the basic plan for delivery of EMS. By this method, if a critical care patient in a certain category is not transferred to a designated Center, the EMS System can question the primary facility as to their decision to retain the patient. In cooperation with the EMS System, SCI planners would have access to this "tracking system" and, thus, obtain epidemiological and etiological information they might not otherwise receive.

We frequently hear discussions as to the efficiency of various treatment protocols in the management of spinal cord injury. One obvious consideration in any discussion of this nature is the timing of the initiation of the protocol. By close collaboration between the SCI and EMS Systems' Directors, the protocol could begin at the accident scene and the evaluations could be made not only within Systems but nationally between Systems. It is also conceivable that inter-relationships between SCI and EMS Systems could result in additional data pertaining to incident scene management being available to the National Spinal Cord Injury Data Research Center.

In order to develop this type of program, Model Systems SCI physicians should contact their state EMS planning agency and the EMS Physician Consultant in the Department of Health and Human Services Regional Office. These contacts will enable the SCI Systems planners to become knowledgeable about the EMS programs of surrounding regions and permit them to assist in designation of SCI Centers, if necessary. Additionally, the information obtained will, perhaps, furnish the basic data necessary to determine the actual needs of the nation in regard to the number and location of SCI Centers for the future. Perhaps, we will find that 70 is not the optimal number of SCI Centers required. In any event, 304 Centers certainly is not the answer.

CORRECTION:

Fall/1980 *SCI DIGEST,* p. 12–13: In Tables 3 and 4, N = CASES *NOT* DAYS. Please note this correction in your copy of the Fall/1980 *DIGEST.*

PSYCHOSOCIAL REDEVELOPMENT OF SPINAL CORD INJURED PERSONS*

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Several sequences of psychosocial events, which may follow spinal cord injury (SCI), are described herein. Such a descriptive approach is useful to the professional because a perspective is gained that leads to a better understanding of the injured individual and the services necessary to help that person achieve an acceptance of, and identify with, his/her changed body image.

A developmental approach is taken based on our experience with allied health professionals over the past two decades. This kind of descriptive framework takes on functional qualities when properly linked with learning strategies and tactics. We hope that the subsequent intervention in the treatment and rehabilitation environment will result in increased effectiveness. Our specific objectives are to:

- Describe the psychosocial aspects of the treatment, rehabilitation, and community environment of spinal cord injured persons.
- Relate these descriptions to Erik Erikson's life span development stages.
- Describe one aspect of the redevelopment process as psychosocial tasks.
- Briefly mention the necessary scope of inquiry and the tactics to accomplish more positive outcomes.

In our opinion, regardless of the theoretical framework or the level of behavioral analysis used, all ablebodied and disabled individuals must face, as Erikson suggests, three issues in their approach to maturity:

- How to deal with the mature body and one's total person in the fullest sense.
- How to share one's total person with significant others.
- How to deal with the products of their lives—sexual procreations and work outcomes.

These tasks, according to Erikson, are resolved in certain social strata (hence they are psychosocial in nature) and during specific historical moments in time (for example, young Freud's achievement of maturity in Vienna was quite different from what it would be today in the U.S.) Regardless of these variables, the sequence of tasks is always the same. Consequently, we can come closer

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HIGH CERVICAL (C1-C4) SPINAL CORD INJURY

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Injury to the spinal cord at the higher cervical levels creates a devastating disability. It may result in true quadriplegia with complete paralysis of the trunk and all four extremities. Except for the head and neck, all bodily interoceptive and exteroceptive sensation is obliterated. There is frequently complete or partial impairment of the ability to breath and mechanical assistance is necessary. The injured individual becomes completely dependent upon others for his very existence. He needs help to perform the entire gamut of his routine daily activities. Yet in spite of this motor and sensory deprivation, the "high quad" retains his cerebral functions intact. He is a normal human being with loves and hatreds, likes and dislikes, fears and concerns, aspirations and frustrations.

The surviving "high quad" is a phenomenen resulting from recent advances in medical care. Pulmonary resuscitation, particularly mouth-to-mouth breathing, has been taught to a relatively large segment of the lay population. As a result, persons injured in diving accidents, auto accidents, et cetera, are supplied life saving oxygen until the arrival of paramedics who are trained and equipped to apply skilled life support measures. Rapid and organized Emergency Medical Services deliver these critically injured people to modern trauma centers or major hospitals where advanced life support systems are readily available. Skilled pulmonary management is supplied while treatment is instituted for the broken spine and other associated injuries. The injured individual not only survives the accident but continues to live through the initial medical period. We are beginning to see a new entity in the surviving spinal cord injured (SCI) population—the high quadriplegic.

High quadriplegia is arbitrarily defined as injury to the spinal cord with the lowest preserved (normal) level at C4 or above. Its unique characteristics include potentially complete paralysis of all four extremities and impairment of respiration. This severe loss of function warrants separation of this group from the lower levels of cervical spinal cord injuries. The accumulation of a large number of documented spinal cord injury cases in the National Spinal Cord Injury Data Bank permits evaluation of some of the characteristics of the "high quad" population. This report presents information resulting from such an evaluation.

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METHODOLOGY

The National Spinal Cord Injury Data Bank currently includes reports of 3,950 SCI cases injured in the years 1975 through 1979. The reports were submitted by the 14 Regional Spinal Cord Injury Systems sponsored by the Rehabilitation Services Administration. From this group, were selected those cases whose lowest preserved (normal) neurological segment was above C5.

Throughout the analysis, those cases that had unknown values, reported in the variables under study, were deleted from that specific study. In those situations where dollar values are reported, the dollars were converted to 1979 values using the price index for selected medical expenses as published in the Statistical Abstracts of the U.S., 1979.

Additional methodology was included, as needed, in reporting the results of this study.

RESULTS

DEMOGRAPHY

Of the 3,950 reported cases, the last preserved (normal) segment of 649 (16.4%) was above the fifth cervical level. This study group represented 30.6 percent of all cervical injuries. The frequency distribution of these cases by neurological level is presented in Table 1. The figures document the level that existed at the time of admission. Unfortunately, the average number of days between injury and admission to the reporting Regional SCI System was 49. Considerable improvement in the neurological status of the reported cases could have occurred during that period of time. Quite possibly some cases entering the Systems with neurological levels of C5 or lower may have had higher levels initially.

A preponderance of the "high quad" population (77.6%) had C4 level injuries. In that persons with preservation of this level usually retain some diaphragmatic function, they have been grouped separately from the C1–C3 cases in many instances throughout this study.

The average age at onset of injury was 29.1 years. The median was 22 years. This is comparable with the mean and median ages of the entire spinal cord injured population which are 28.5 and 23 years, respectively. The distribution according to sex was slightly higher toward males (86%) than the entire SCI population (82%). The percentage of injuries with complete loss of motor and sensory function below the level of injury compared closely with the total SCI population (48% to 49% respectively). The distribution of the study population by the year of injury was:

Year of Injury	*Percent*
1975	13
1976	18
1977	22
1978	25
1979	22

ETIOLOGY

The causes of injury compare closely with the entire quadriplegic population (Table 2). There appears to be a slightly higher percentage of vehicular accidents and falls and lower percentage of sports injuries in the "high quad" group.

NEUROLOGICAL CHANGES

Neurological changes following spinal cord injury must be described using two different parameters: the changes that occur within the zone of injury, and those that occur distal to the zone of injury.

Table 1. NEUROLOGICAL LEVEL LAST PRESERVED ANATOMICAL SEGMENT HIGH QUADS (C1-C4) ONSET-OF-INJURY 1975–1979

NEUROLOGICAL LEVEL	CASES	
	N	%
C1	23	4
C2	35	5
C3	87	14
C4	502	77
C1–C4	647	100

Table 2. ETIOLOGY HIGH QUADRIPLEGICS (C1–C4) ONSET-OF-INJURY 1975–1979

ETIOLOGY	QUADRIPLEGICS		
	HIGH (C1–C4)		ALL*
	N	%	%
Vehicular Accidents	323	50	46
Sports	147	23	28
Falls	103	16	14
Penetrating Wounds	54	7	6
Other	20	4	6
All	647	100	100

**Model Systems' SCI DIGEST*, 1, Spring 1979

The former involves the neurons and roots within the injury segments. The latter involves the axons passing through the injured segments enroute to lower or higher receptors. The methodology to describe neurological change distal to the injury developed by Frankel and colleagues[1] has been used in this study. The gross neurological grades leave something to be desired in that they are not equal in terms of functional importance and have a judgmental interface between motor-useless and motor-useful. However, with comparatively large series of cases, they are useful for statistical documentation. The neurological change distal to the zone of injury experienced by cases in this study is presented in Table 3. The cases reported in the diagonal boxes are those who were admitted in the designated grade and discharged with no neurological change. The cases to the left of the diagonal are those that lost function. The cases to the right gained function.

In this series, there were 622 cases with known values for neurological recovery on both admission and discharge. Twenty-seven cases had unknown values. Three hundred forty-three cases (55%) were diagnosed as complete injuries on admission. Of these, 327 cases (95%) remained complete. Seven cases (2%) gained some sensation and a similar number gained motor-useless function. Two cases gained useful motor function. No cases recovered.

A systematic study of the table provides similar information for the cases admitted in the other neurological grades. One hundred twenty-one cases were admitted with useful motor function. Of these, 106 (88%) stayed the same; seven recovered completely; and eight became worse. Two of these cases became complete injuries.

The original Frankel study was confined to cases admitted within 14 days of injury. As mentioned previously, the cases in this study were admitted on an average of 49 days from injury. Unquestionably, considerable neurological change had already occurred in some of the cases prior to admission.

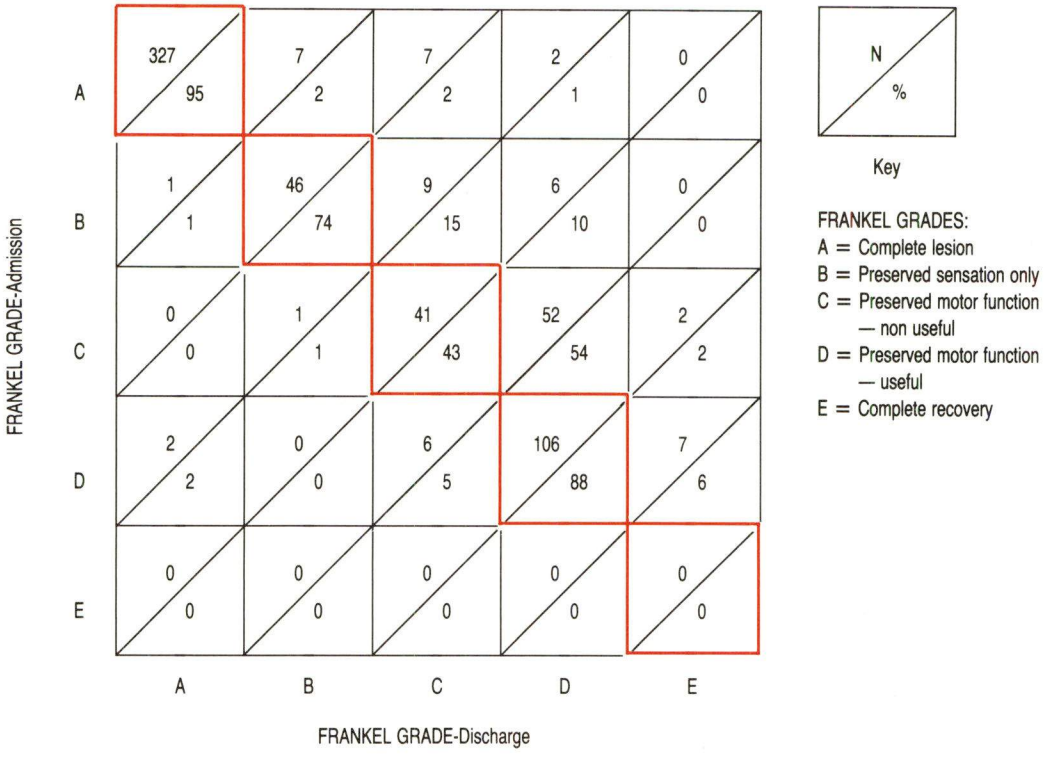
The composite experience of neurological change within the zone of injury in this study is documented in Table 4. Since neurological change within the injury zone may occur rapidly, a group of cases that were admitted to the reporting SCI Systems within 24 hours of the onset-of-injury were selected to study neurological change. One hundred fifty-eight cases qualified. Again the diagonal boxes represent those cases that were diagnosed as having the indicated neurological level on admission and did not change by the time of discharge. Of particular note is that of the 125 cases admitted with a C4 level, over one-fourth (28.8%) regained C5 or better function. This

1. Frankel, HL, et al. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. *Paraplegia,* Volume 7, pp. 179, 1969-70.

Table 3. NEUROLOGICAL CHANGE BETWEEN ADMISSION AND DISCHARGE

High Quadriplegics (C1-C4)
Onset-of-Injury 1975-1979

Total Cases = 622



represents a very significant improvement in terms of diaphragm and upper extremity function. Unfortunately, four cases admitted with C4 neurological levels ascended to higher levels. Thirty-three percent of the entire group experienced a lowering of the neurological level by at least one segment.

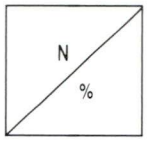
MORTALITY

The methodology of data collection developed for the National Spinal Cord Injury Data Research Project has deficiencies. It provides no information, of course, as to deaths that occur within the catchment area either at the site of injury or in cases admitted to other hospitals where death occurs before transfer to a System hospital is accomplished. The shortest time interval between onset-of-injury and admission to a SCI System hospital reported to the National Center is one day. As a consequence, we cannot report the death rate occurring within the first few hours of injury. Lastly, cases arriving at the System hospitals who do not survive the emergency room are not reported. This undoubtedly contributes to some element of under-counting. To study mortality, a group of 182 "high quads" were identified as having been admitted within 24 hours of the onset-of-injury. This permits determination of the death rate for a group of cases, identified within one day, as having survived the initial injury. Of these cases, 23 (12.6%) died during initial System hospitalization. Sixteen died within 30 days. Eighteen were dead within 60 days. Twenty-two died within 120 days. One case expired 183 days from injury.

Table 4. NEUROLOGICAL CHANGE WITHIN THE ZONE OF INJURY BETWEEN ADMISSION AND DISCHARGE

High Quadriplegics (C1-C4)
Cases Admitted Within 24 hours of Onset-of-Injury

Total Cases = 158



Key

NEUROLOGICAL LEVEL-Admission	C1	C2	C3	C4	C5	C6	C7	Recovery
C1	1 / 100	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C2	0 / 0	4 / 50	1 / 13	2 / 25	0 / 0	0 / 0	0 / 0	1 / 13
C3	0 / 0	1 / 4	11 / 46	6 / 25	3 / 13	0 / 0	1 / 4	2 / 8
C4	1 / 0.8	1 / 0.8	2 / 2	85 / 68	27 / 22	4 / 3	1 / 0.8	4 / 3

NEUROLOGICAL LEVEL-Discharge

For twenty-two of the cases, the primary cause of death was cardio-pulmonary complications. One case died of meningitis secondary to an infected wound to the spinal canal.

It is interesting that the deaths tended to occur in an older population. The average age at onset for the mortality group was 42.5 years compared to 31.7 years for the "high quad" group, admitted within 24 hours, and 28.5 years for the entire cervical injury group. The group of cases that died consisted of a higher proportion of complete injuries, 83 percent compared to 53 percent in the entire early admission group.

UTILIZATION OF MECHANICAL RESPIRATION

The utilization of mechanical respiration during the course of the initial medical-rehabilitation period is presented in Table 5. The percentage of cases requiring mechanical assistance to breath is related to the level of the injury. An unexpected result is the relatively few cases at the C4 level who required respirators. Three-fourths of them required no assistance throughout the initial hospitalization period. Only 3 percent of the C4 injuries were discharged with ventilation aid. A number of factors contribute to the seemingly low utilization rate. A large percentage (51%) are incomplete injuries and may have had some diaphragmatic or even intercostal function. Further, many of them recover function within the zone of injury and, as a consequence, experience some re-innervation of the diaphragm, providing reduced but adequate ventilation. Lastly the accessory muscles of respiration can be strengthened by training, thereby, increasing the chances for the individual to become respiratory independent.

Table 5. HIGH QUADRIPLEGICS (C1-C4) REQUIRING MECHANICAL RESPIRATION DURING INITIAL MEDICAL-REHABILITATION PERIOD
Onset-of-Injury 1975–1979

NEUROLOGICAL LEVEL	ALL CASES N	MECHANICAL RESPIRATION REQUIRED					
		PRIOR TO SYS. ADMISSION		DURING SYS. HOSPITALIZATION		AT DISCHARGE	
		N	%*	N	%*	N	%*
C1	23	20	87	16	70	15	65
C2	35	26	74	25	71	17	49
C3	87	47	54	45	52	17	20
C4	502	119	24	101	20	17	3

*Percent of ALL CASES

DAYS HOSPITALIZED

The days hospitalized during the initial Medical Rehabilitation period is presented in Table 6. Referral of "high quads" to systems appear to be somewhat delayed. The C4 group averages 45 days from injury to System admission. The higher levels average considerably longer. Although there is considerable variance in the length of time spent in the System Hospital, the biggest variance occurs in the time spent in the Pre-System Hospitals. It has been repeatedly observed that the length of stay in the Spinal Cord Injury Center remains relatively constant. Total days hospitalized is primarily effected by the time it takes for the injured individual to get into the System. This appears to be particularly true in high quadriplegics. The presence of incomplete injuries, many of whom have considerable neurological function, reduces the over-all length of stay. To demonstrate this, a group of 240 complete injuries (excluding deaths) were identified. This group averaged 189 days total hospitalization. There was approximately 20 day difference in all neurological levels between complete injuries and the total "high quad" group.

TOTAL HOSPITALIZATION EXPENSE

Three hundred sixty-four cases had reported actual total values in the hospital expense variable. The data collection methodology requires that these be precisely obtained from total hospital billings. The mean initial hospital expense for the entire group was $60,000. The C1-C3 group

Table 6. DAYS HOSPITALIZED: INITIAL MEDICAL-REHABILITATION PERIOD*
High Quadriplegics (C1-C4)
Onset-of-Injury 1975–1979

NEUROLOGICAL LEVEL	CASES N	HOSPITALIZATION					
		PRE-SYSTEM		SYSTEM		TOTAL	
		$\bar{X}$	S/D	$\bar{X}$	S/D	$\bar{X}$	S/D
		(DAYS)		(DAYS)		(DAYS)	
C1	15	77	74	124	91	201	127
C2	21	68	82	167	145	235	159
C3	50	64	72	117	51	181	94
C4	369	45	57	118	58	164	74
C1–C4	455	49	61	120	65	170	65

*Excluding deads

Table 7. TOTAL HOSPITALIZATION EXPENSE: INITIAL MEDICAL-REHABILITATION PERIOD
Onset-of-Injury 1975–1979

NEUROLOGICAL CATEGORY	CASES N	HOSPITAL EXPENSE*			
		$\bar{X}$	S/D	MEDIAN	MAX
C1–C3	66	$84	$65	$69	$321
C4	298	55	36	44	265
C1–C4	364	60	44	47	321

*In thousands—1979 dollars.

averaged $84,000 and the C4 group was $55,000. See Table 7. The high expense associated with the C1–C3 group documents a high service utilization. This is primarily for Respiratory Therapy Laboratory, X-ray and equipment rental. The computed average per-diem rate for the C1–C3 group was $454 dollars per day (1979 dollars). The computed average per-diem rate for the C4 group was $346.

Obviously, "high quads" are expensive. Forty-seven cases (13%) had initial hospitalization expenses over $100,000. Eight cases were between 100 and 200 thousand dollars. One case had $320,000 initial hospital expenses.

DAYS HOSPITALIZED FOLLOWING THE INITIAL MEDICAL AND REHABILITATION PERIOD

The ideal method for following rehospitalization over the years after initial discharge would be to identify a group of cases that had known actual values in the hospital expenses variable in all of the Follow-Up Years being studied. Unfortunately, this creates a small sample in that it would include only those cases injured in the earlier years of data collection. For example, a Three-Year Follow-Up Study would include only cases injured prior to 1977. A slightly less desirable but acceptable method is to group all cases reported for a specific Follow-Up Year regardless of the year of injury. This method was used to generate the information presented in Table 8. Two hundred forty-two cases of high quadriplegia had reports for Follow-Up Year 1, 136 for Year 2 and 62 for Year 3. The mean days hospitalized in Follow-Up Year One was 11. It must be explained that this first Follow-Up Year represents only the remaining days following the initial hospitalization period in the year after onset-of-injury. As noted in Table 6, the average total days for the initial hospitalization period was 170 for all "high quads". Between discharge and the anniversary date of injury, an additional 11 days average hospitalization occurred. Thus, the total days hospitalized for the first year following injury would be 170 + 11 = 181 days. The average days hospitalized for all cases includes cases requiring no hospitalization. However, it is markedly weighted by the large number of cases requiring no hospitalization. Only 41 percent of the cases reported in Follow-Up Year 1, 61 percent in Year 2 and 50 percent in Year 3 were admitted to hospitals. Table 8 also documents the mean days hospitalized for those cases actually hospitalized.

Table 8. DAYS HOSPITALIZED FOLLOWING INITIAL MEDICAL-REHABILITATION PERIOD
High Quadriplegics (C1–C4)
Onset-of-Injury 1975–1979

FOLLOW-UP YEARS	RE-HOSPITALIZATION						
	ALL CASES			HOSPITALIZED CASES ONLY			
	N_1	$\bar{X}$	S/D	N_2	%*	$\bar{X}$	S/D
		DAYS				DAYS	
1	242	11.2	22.6	98	41	27.5	28.6
2	136	20.2	40.3	83	61	33.1	47.3
3	62	16.3	30.1	31	50	32.5	35.9

*(N_2/N_1) 100

RE-HOSPITALIZATION EXPENSE FOLLOWING THE INITIAL MEDICAL-REHABILITATION PERIOD

The actual hospitalization expenses, confirmed by hospital billings were reported for 222 cases in Year 1, 119 cases in Year 2 and 33 cases in Year 3, see Table 9. As with total days hospitalized, the $3,800 re-hospitalization expense incurred in Follow-Up Year 1 must be added to the $60,000 incurred in the initial hospital expense to obtain the total cost of hospitalization in the first 365 days following injury. For all "high quads", this would amount to $63,800. Dollars have been converted to 1979 values. The average expense for all cases was $5,200 in Follow-Up Year 2 and $4,300 in Year 3. The average expense for those cases actually hospitalized is considerably higher.

Table 9. RE-HOSPITALIZATION EXPENSE FOLLOWING INITIAL MEDICAL-REHABILITATION PERIOD
High Quadriplegics (C1–C4)
Onset-of-Injury 1975–1979

FOLLOW-UP YEAR	RE-HOSPITALIZATION EXPENSE*						
	ALL CASES			HOSPITALIZED CASES ONLY			
	N_1	$\bar{X}$	S/D	N_2	%**	$\bar{X}$	S/D
1	222	$3.8	$10.7	94	42	$9.1	$15.0
2	119	5.2	11.6	72	61	8.6	14.0
3	33	4.3	7.7	24	45	9.5	9.1

*In thousands—1979 dollars
**(N_2/N_1) 100

ATTENDANT CARE

When the National Spinal Cord Injury Data Bases was being developed, it was anticipated that custodial and attendant care would be a major on-going expense for quadriplegics. Four variables were designed to provide data relevant to this expense. They were:

- Hired attendant care used.
- Average hours of hired attendant care per week.
- Average hourly wage paid.
- Actual hours of physical assistance required for a 24-hour period.

The first three variables were unrelated to the attendant care provided by family or friends without charge. The actual hours of physical assistance required is irrespective of who provides it—hired attendant, family, friends or others. As could be expected, the values reported represent only estimates and are not as reliable as the values reported for days hospitalized or hospitalization costs. Nevertheless, they do represent reasonable approximations of attendant care utilization and costs.

Data pertaining to hired attendant care is presented in Table 10. Because of the relatively small numbers and the fact that there is little variance among the higher neurological levels, C1, C2 and C3 cases were grouped together. Also the data represents the accumulated experience of Follow-Up Years 1, 2 and 3. Approximately half of the "high quads" utilized hired attendants. There are undoubtedly a number of factors contributing to whether a hired attendant is utilized, not the least of which is available resources to pay for such care. For example, 91 of the cases reporting utilization of hired attendant care were covered by Workmen's Compensation. Fifty-nine percent of this group had hired attendants providing 83 hours of hired attendant care per week. Compared to an average 47 percent of the cases and 52 hours for the whole group.

Of those reporting the utilization of attendant care, the average estimated hours utilized per week was 64 for the C1–C3 group and 50 for the C4 group. All cases reported an average of 52 hours. The average hourly wage was relatively low probably indicating a low level of professional training. The higher value for the C1–C3 group perhaps shows a higher professional level. Of course, there is considerable regional variation in hourly wages.

Table 10. HIRED ATTENDANT CARE
High Quadriplegics (C1–C4)
Onset-of-Injury 1975–1979

NEUROLOGICAL CATEGORY	ALL CASES N_1	HIRED ATTENDANT CARE			
		CASES		HOURS/WEEK	HOURLY WAGE
		N_2	%*	$\bar{X}$ (hrs)	$\bar{X}$**
C1–C3	103	47	45.6	64.0	$4.65
C4	475	226	47.4	49.5	3.45
C1–C4	578	272	47.1	52.0	3.65

*(N_2/N_1) 100
**1979 dollars

A rough estimation of the cost of attendant care can be obtained by multiplying the average hourly wage and the average hours/weeks x 52 weeks per year. The resulting values suggest that attendant care is the largest expense item in the on-going care budget for the "high quad". The resultant annual expense for the C1–C3 group is $15,000, three times the annual hospitalization expense. Similarly, the estimated annual attendant care for the C4 group is $8,800 and $9,900 for the entire "high quad" group.

The estimated average hours of actual physical assistance required for a typical 24-hour period is presented in Table 11. As mentioned before, this is irrespective of who provides it. At first glance, it is surprising that between 15 and 21 percent need no assistance. It must be remembered that, as documented in Table 3, 175 of the cases (28%) were discharged with useful motor function below the zone of injury. Undoubtedly most of the cases who were independent of assistance came from this group. The average hours of assistance required per day does not appear to vary over the Follow-Up Years.

RESIDENCE DURING FOLLOW-UP YEARS

An unexpected result was the large proportion of high quadriplegics who were discharged to a home environment, see Table 12. This held constant in the neighborhood of 80 percent throughout the first three years following injury. Only five to six percent were maintained in nursing homes, a far cry from our experience 10 or 20 years ago. The results are particularly good when one considers this study is confined to quadriplegics above the C5 level.

Table 11. ESTIMATED AVERAGE HOURS PHYSICAL ASSISTANCE REQUIRED/24-HOUR PERIOD

High Quadriplegics (C1–C4)
Onset-of-Injury 1975–1979

FOLLOW-UP YEAR	ALL CASES N_1	PHYSICAL ASSISTANCE REQUIRED					
		NONE		ACTUAL/24-HOUR PERIOD			
		N_2	%*	N_3	%**	$\bar{X}$	Median
						hours	
1	198	42	21	156	79	8.7	7
2	128	21	16	107	84	9.5	7
3	58	9	15	49	85	7.0	5

*(N_2/N_1) 100
**(N_3/N_1) 100

Table 12. RESIDENCE DURING FOLLOW-UP YEARS ONE THRU THREE

High Quadriplegics (C1–C4) Onset-of-Injury 1975–1979

RESIDENCE CATEGORY	FOLLOW-UP YEAR					
	ONE		TWO		THREE	
	N	%	N	%	N	%
Private Residence	229	79	143	82	60	81
Hospital	5	1.7	5	2.8	3	4.3
Nursing Home	19	6.6	11	6.4	4	5.3
Group Living	8	2.8	3	1.7	2	2.7
Deceased	9	3.0	8	4.6	0	0
Unknown	20	6.9	4	2.4	5	6.7
Total	290	100	174	99.9	74	100

SUMMARY

A group of 649 persons with traumatic spinal cord injury, with the lowest preserved (normal) level at C4 or above, were selected from 3,950 cases reported to the National SCI Data Research Center. The group represented 31 percent of all cervical injuries and 16 percent of all spinal cord injuries. The bulk (78%) of this "high quad" group had C4 level injuries. Forty-nine percent had complete paralysis and loss of sensation below the zone of spinal cord injury.

There were minor differences in the demography and epidemiology between the "high quad" group and all cervical injuries.

The pattern of neurological recovery below the injury is grim. Ninety-five percent of those admitted with complete injuries remained complete. Only nine cases had a complete recovery and seven of these had useful motor function on admission. However, thirty-three percent experienced a lowering of the neurological level by at least one segment during the initial hospital period.

Twenty-three (12.6%) out of 182 "high quads" admitted within 24 hours of injury expired during initial hospitalization. The primary cause of death was cardio-pulmonary complications in 22 of the 23 cases.

The utilization of mechanical respiration is related to the level of injury. Sixty-five percent of the C1 level cases were discharged using respirators compared to only three percent injured at the C4 level.

The "high quad" group averaged 170 days initial hospitalization at a mean cost of $60,000. The group injured at the C1–C3 levels averaged $84,000 and the C4 group, $55,000.

Preliminary data reveals the extent of re-hospitalization that may be expected in the second and third years following injury: 20 days in Year 2 and 16 days in Year 3 at an average cost of $5,200 and $4,300, respectively. Values were converted to 1979 dollars.

Attendant care for the "high quad" group will undoubtedly be the major expense item for on-going care. Approximately half of the group had hired attendants averaging 52 hours a week.

An amazing number of "high quads" are able to live in a private home environment. Only five to six percent were maintained in nursing homes.

METABOLIC DYSFUNCTIONS FOLLOWING SPINAL CORD INJURY

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In 1968, I was asked by Dr. Howard A. Rusk to direct and equip a metabolic research laboratory that would serve to elucidate dysfunctions that follow spinal cord injury (SCI). I was told that I would be working closely with Dr. Edward W. Lowman, then the Clinical Director, who had received endowment funds from Edmond Guggenheim as well as Marie and Leonie Guggenheim designated for the expressed purpose of investigating metabolic disturbances in spinal cord injury. Dr. Lowman was aware of the vast knowledge gaps that existed with respect to the pathophysiological sequelae of SCI. His eagerness to uncover the basis of the many dysfunctions of SCI fired our imagination and enthusiasm. Our complete emersion in the problem led to the establishment of the unique Laboratory of Biomedical Pharmacology staffed with personnel and specialized equipment to handle the multifaceted functional derangements in SCI. This was aided by the designation of the Institute of Rehabilitation Medicine (IRM) as the New York Regional Spinal Cord Injury System (NYRSCIS) and a four-year grant from the Rehabilitation Services Administration and the National Institute of Health Research (RSA/NIHR).

For the sake of brevity, this report will give a cursory review of only three areas of dysfunction following spinal cord injury.

- Bone Mineral Metabolism
- The Endocrine System
- The Autonomic Nervous System

DYSFUNCTION OF BONE MINERAL METABOLISM

OSTEOPOROSIS

A frequent and serious complication of spinal cord injury, occurring immediately after the onset of the lesion, is the loss of bone minerals and bone matrix. This loss of bone (resorption) results from a concomitant loss of calcium and hydroxyproline. The latter is a major amino acid found in collagen which is the main component of the bone matrix. This progressive loss of bone leads to osteoporosis and a negative calcium balance.

In SCI, extremely rapid and progressive loss of bone is often associated with kidney stone formation, pathologic fractures and the development of ectopic bone. At times, these complications limit the rehabilitation, independence and employability of spinal cord injured individuals.

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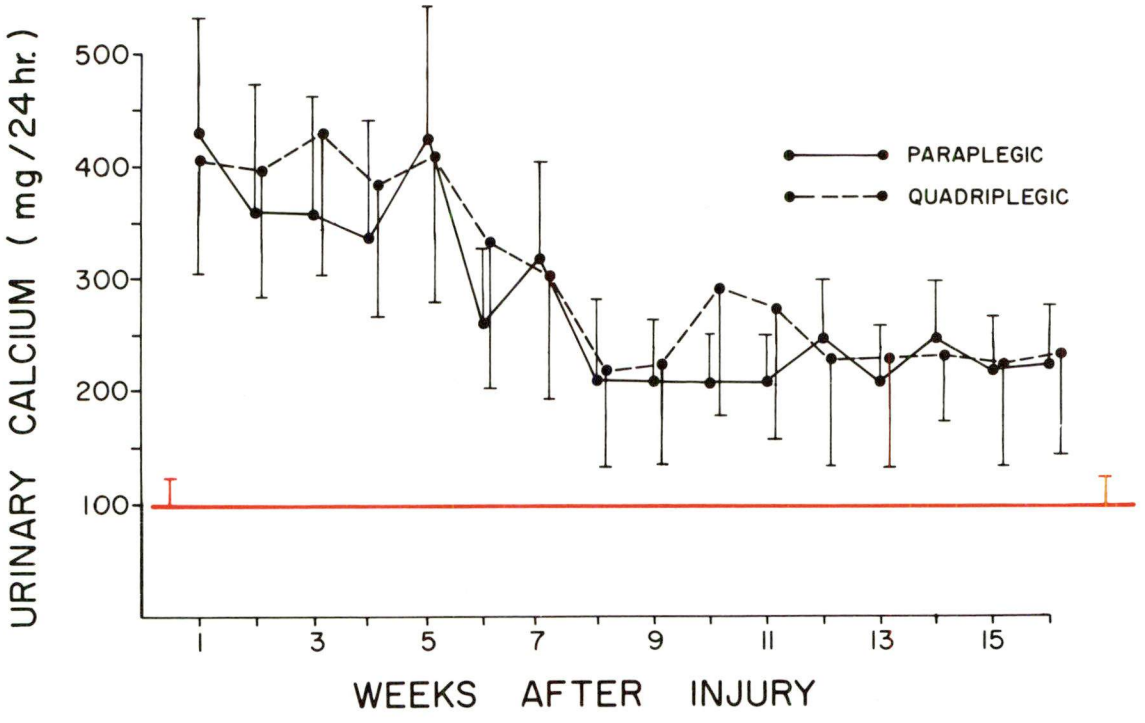
* Professor of Rehabilitation Medicine

The purpose of the studies on bone demineralization were to:

- Determine when the process of loss begins.
- Find the extent and duration of the loss.
- Find the reason for the loss.
- Retard and/or prevent the loss.

The results of our work and those of other investigators have shown that hypercalciuria occurs in SCI during the first six months post-injury and that the calcium excretion becomes less severe thereafter presumably due to increased patient activity.[1-4] Until recently, a longitudinal investigation of the degree of calcium and hydroxyproline loss, measured at weekly intervals, in paraplegic and quadriplegic subjects had not been conducted. The data from our longitudinal study (Figure 1) shows that the increase in urinary calcium starts almost immediately after the onset-of-injury. The elevated urinary calcium cannot simply be attributed to prolonged inactivity since the degree of calciuria is greater in spinal cord injured persons than in able-bodied subjects following prolonged bed rest.

Figure 1. URINARY CALCIUM EXCRETION (Mean ± SD) of 10 PARAPLEGICS AND 10 QUADRIPLEGICS 1 TO 16 WEEKS AFTER SPINAL CORD INJURY



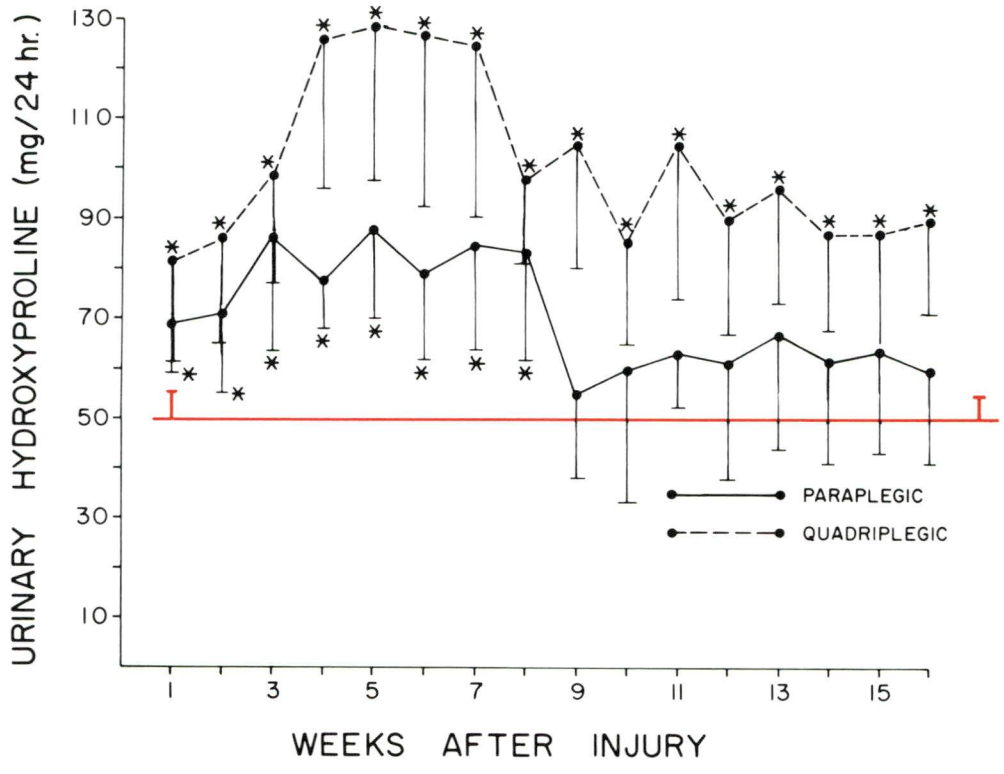
Note: Horizontal line represents urinary calcium excretion of 10 able-bodied control subjects. All values obtained for the paraplegic and quadriplegic subjects are significantly higher ($p = <0.05$) than those of the controls

Total urinary hydroxyproline is used as a sensitive index and quantifier of bone collagen metabolism. An increase in urinary hydroxyproline following SCI indicates collagen breakdown and bone resorption. In our longitudinal studies, we found that the excretion of hydroxyproline was greater and of longer duration in quadriplegics than in paraplegics (Figure 2.). The correlation between hydroxyproline and calcium excretion in spinal cord injured subjects (Figures 1 and 2), without concomitant marked increases in serum alkaline phosphatase, indicates that the loss of calcium and hydroxyproline is consistent with bone resorption.

Thyrocalcitonin usually counteracts parathormone to keep plasma and bone exchange of calcium at a constant level. This hormone's effect is produced by the inhibition of bone resorption, especially when bone resorption is stimulated by the parathyroid hormone. Parathyroid hormone is also known to increase urinary excretion of hydroxyproline. Possibly, the main effect of thyrocalcitonin in humans is to protect against excessive bone loss due to parathyroid hormone.

In our studies on animal models with SCI, administration of thyrocalcitonin to paraplegic rats resulted in a marked improvement of calcium, phosphorus, and magnesium balances that were depressed following SCI. Another significant finding was that after transection of the spinal cord at the T5 level the survival rate in thirty untreated male Wistar rats was 25 percent. Death usually occurred within eight to fourteen days after transection although the urinary bladder was expressed three times daily. Autopsy revealed hydronephrosis of the kidneys which occurred either bilaterally,

Figure 2. URINARY HYDROXYPROLINE EXCRETION (Mean ± SD) OF 10 PARAPLEGICS AND 10 QUADRIPLEGICS 1 TO 16 WEEKS AFTER SPINAL CORD INJURY



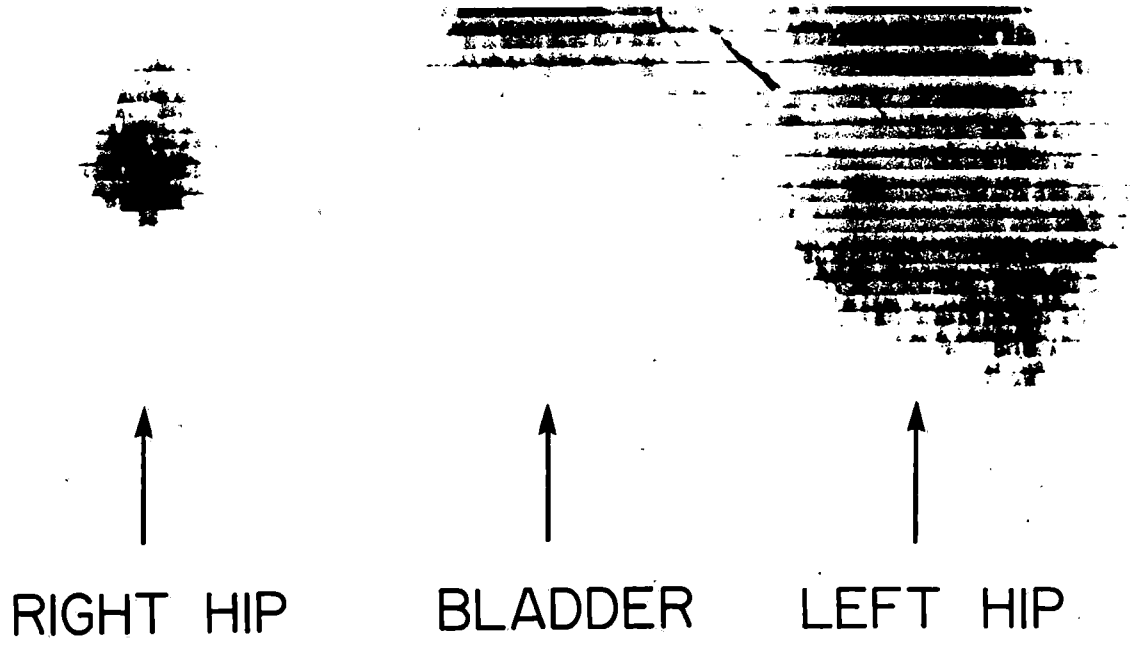
NOTE: Horizontal line represents urinary hydroxyproline excretion of 10 able-bodied control subjects. (* = $p<0.05$)

or, more often, unilaterally on the right side. Thyrocalcitonin administered subcutaneously increased the survival rate to 80 percent and markedly reduced the incidence of hydronephrosis.[5]

HETEROTOPIC OSSIFICATION

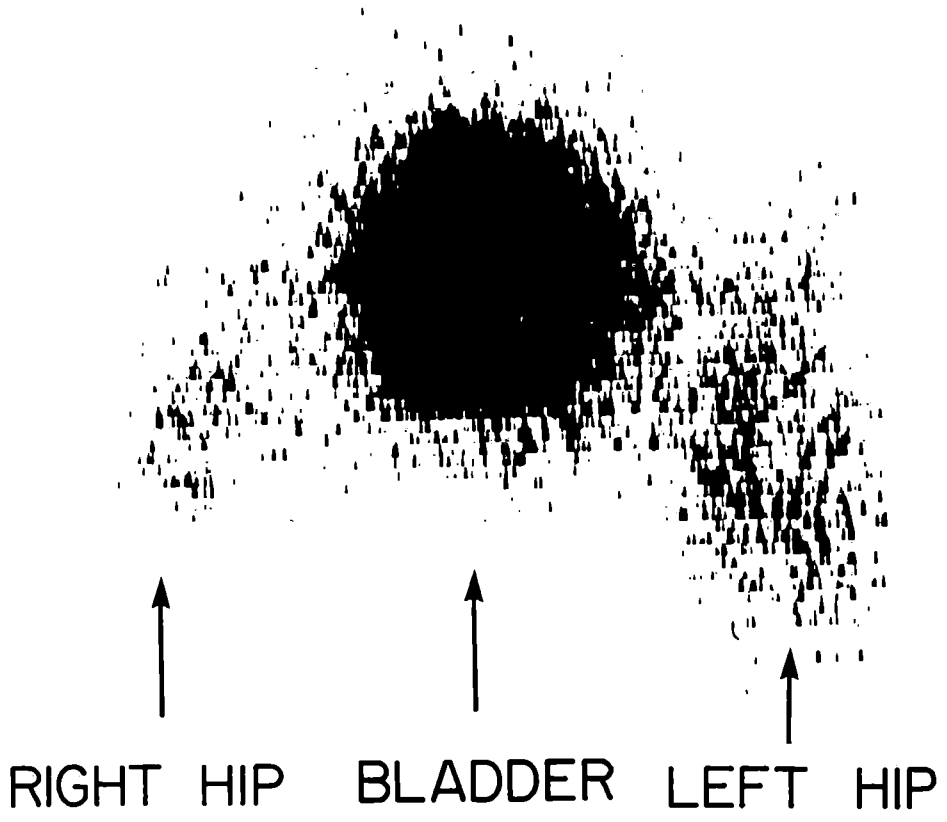
Another complication of SCI is heterotopic ossification (myositis ossificans, extraskeletal, ectopic, or periarticular bone) which occurs in 16 to 53 percent of SCI victims. This condition starts as an inflammatory reaction causing edema, chrondrogenesis, and osteogenesis. Its etiology may possibly be related to autonomic dysfunctions commencing with the appearance of venuous thrombosis and arterio-venuous shunts in the affected area.[6] The intimate association of osteoporosis with periarticular ossification indicates that excessive calcium loss from bones is one of the predisposing factors in the formation of ectopic bone. In a preliminary study, the effect of thyrocalcitonin on ectopic bone was studied in three subjects. One paraplegic subject with long duration periarticular ossification of both hips was treated for a month with thyrocalcitonin. The serum ionized calcium, which is the exchangeable calcium between bone and plasma, decreased significantly after thyrocalcitonin therapy while the total calcium did not change appreciably. The results of ^{18}F scintimetry revealed that, after one month of thyrocalcitonin treatment, the enormous uptake observed before treatment had diminished to insignificant amounts in the affected areas (Figures 3 and 4). Clinically the range of motion in the above paraplegic subject increased by 25 degrees (from -35 to -10) and localized pain was significantly decreased. These results were not duplicated in the two other paraplegic subjects with short duration heterotopic ossification to thyrocalcitonin therapy is different from that of one almost grown to maturity.[7] The maturity of the heterotopic ossification is also of great importance in surgical intervention as well. Surgery performed too early results in the regrowth of the extraskeletal bone.

Figure 3. RESULTS OF ^{18}F SCINTIMETRY ON A PARAPLEGIC SUBJECT (Case 1) WITH LONG-STANDING PERIARTICULAR OSSIFICATION OF BOTH HIPS. [BEFORE THYROCALCITONIN TREATMENT]



NOTE: Bladder is used as reference point. Note the enormous ^{18}F uptake-specially in the left hip area.

Figure 4. SAME SUBJECT AS IN FIGURE 3 AFTER ONE MONTH OF SALMON THYROCALCITONIN TREATMENT



NOTE: Subject received 100 MRC units/day for two weeks and 100 MRC units every other day for two more weeks. A marked diminution of ^{18}F uptake was noted in both hips.

Another pharmacologic agent, diphosphonate, administered in large doses, was found to block or retard the progressive soft tissue ossification in adults and children with myositis ossificans pregressive and prevented the recurrence of calcification after surgical removal of ectopic bone.[8–11] Thyrocalcitonin and diphosphonate ameliorating effects on heterotopic ossification must be compared for efficacy as well as minimum side effects.

RENAL CALCULI

A further complication following SCI is the formation of renal calculi (kidney stones). Formation of kidney stones appears to be favored when the concentrations of sodium and potassium in the urine is decreased and that of calcium is increased.

Based on speculation that a low calcium diet may reduce hypercalciuria and prevent renal calculi and periarticular bone formation, the calcium intake of paraplegic and quadriplegic patients is often restricted. Findings of rapid bone mineral loss following SCI lead to the conclusion, however, that a low calcium diet may exacerbate bone resorption leading to the early development of osteoporosis.

In our recent study of the effect of a calcium diet, rats fed on high calcium diets had normal calcium balance following spinal cord transection as compared with a significantly depressed calcium balance in rats on normal calcium diets. Rats fed high calcium diets also retained more calcium than animals receiving the normal calcium ration. The testes and prostrates in paraplegic rats fed a normal calcium diet were atrophied compared with the controls. No atrophy was observed in rats fed a high calcium diet. Although in the preliminary stage, the data indicate that the occurrence of urinary tract infections was more prevalent and of longer duration in paraplegic rats fed a normal calcium diet than in those fed a high calcium diet. Furthermore, hydronephrosis occurred in several paraplegic rats fed the regular calcium diet but not in animals fed the high calcium diet. Examination of the kidneys and bladders in the transected rats fed a high calcium diet revealed no evidence of renal or bladder calculi. Continued work on low calcium diets is in progress.

DYSFUNCTION OF THE ENDOCRINE SYSTEM

Spinal cord injuries in the human male results in various degrees of testicular atrophy and sterility in the majority of subjects and, in some cases, gynecomastia follows. The occurrence of mammary hypertrophy which is found occasionally in men with SCI may appear as early as three months or as late as five years after the onset-of-injury. Testicular atrophy is reported to occur in over 50 percent of human males. Metabolic and hormonal disturbances causing the impairment of fertility in spinal man are not yet fully understood.

It is well known that in patients with spinal cord lesions above the sympathetic outflow, body heat regulation becomes extremely irregular due to the loss of sympathetic hypothalamic control of sweating and the skin blood flow regulation. There is no explanation as to why some patients with SCI develop stress intolerance, hynecomastia, testicular atrophy, amenorrhea, etc., all manifestations of disturbed functioning of the endocrine system.

PITUITARY TESTICULAR AXIS

In our recent studies, concentrations of testosterone, luteinizing hormone (LH), and follicle stimulating hormone (FSH) in the serum of ten paraplegic and ten quadriplegic subjects were measured once a week for a period of four months from the onset-of-injury. In paraplegic subjects, serum FSH and testosterone levels were significantly lower than those of the age-matched normal controls for a period of two and six weeks after SCI, respectively. Following the above periods of time, serum concentrations of both hormones were not significantly different from those of the controls. In paraplegic subjects, serum LH concentrations were also within control levels. By contrast, in quadriplegic subjects, serum FSH was depressed for three weeks while testosterone and LH concentrations remained significantly lower than those of the controls during the entire four month test period (Figures 3 and 4). Furthermore, in another group of ten chronic (one-to-six years after onset-of-injury) paraplegic and ten chronic quadriplegic subjects, serum FSH concentrations were comparable to those of the normal controls.[12] Although serum LH concentrations were at control levels in chronic paraplegic they were significantly depressed in chronic quadriplegic subjects (Table 1).

Whether the depressed serum testosterone was due to a primary testicular deficiency or to a decreased secretion of LH from the pituitary gland causing less stimulation of testicular Leydig cells remains to be investigated. In addition, it is not known whether low serum LH levels are due to pituitary deficiency or to a low level of pituitary stimulation by the hypothalamic LH releasing hormone. The low concentrations of the latter hormone could result from altered feedback involved in the function of the hypothalamic-pituitary-gonadal axis is permanently disturbed in the acute and chronic quadriplegic subjects (Figures 5 and 6, and Table 1).

Table 1. AVERAGE SERUM LH AND FSH CONCENTRATION FOR CHRONIC PARAPLEGIC, CHRONIC QUADRIPLEGIC AND ABLE/BODIED CONTROL SUBJECTS.

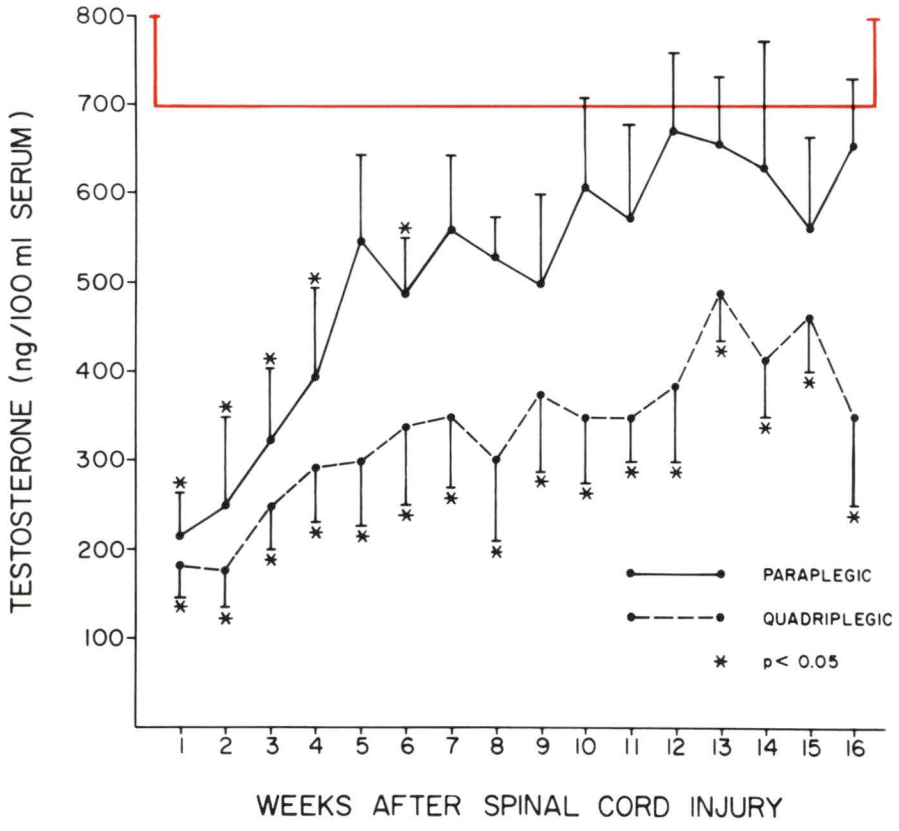
TEST SUBJECTS		TIME AFTER ONSET-OF-INJ.	SERUM LH (mean ± SD)	SERUM FSH (mean ± SD)
CATEGORY	N	YEARS	MIU/ML	MIU/ML
CHRONIC PARA	10	1–6	18.0 ± 2.3	11.1 ± 2.2
CHRONIC QUAD	10	1–6	13.0 ± 2.0*	10.9 ± 2.0
Able-Bodied Control	10	—	19.0 ± 2.0	8.6 ± 2.4

*Significant, $p < 0.05$

RESPONSE TO INSULIN-INDUCED HYPOGLYCEMIA

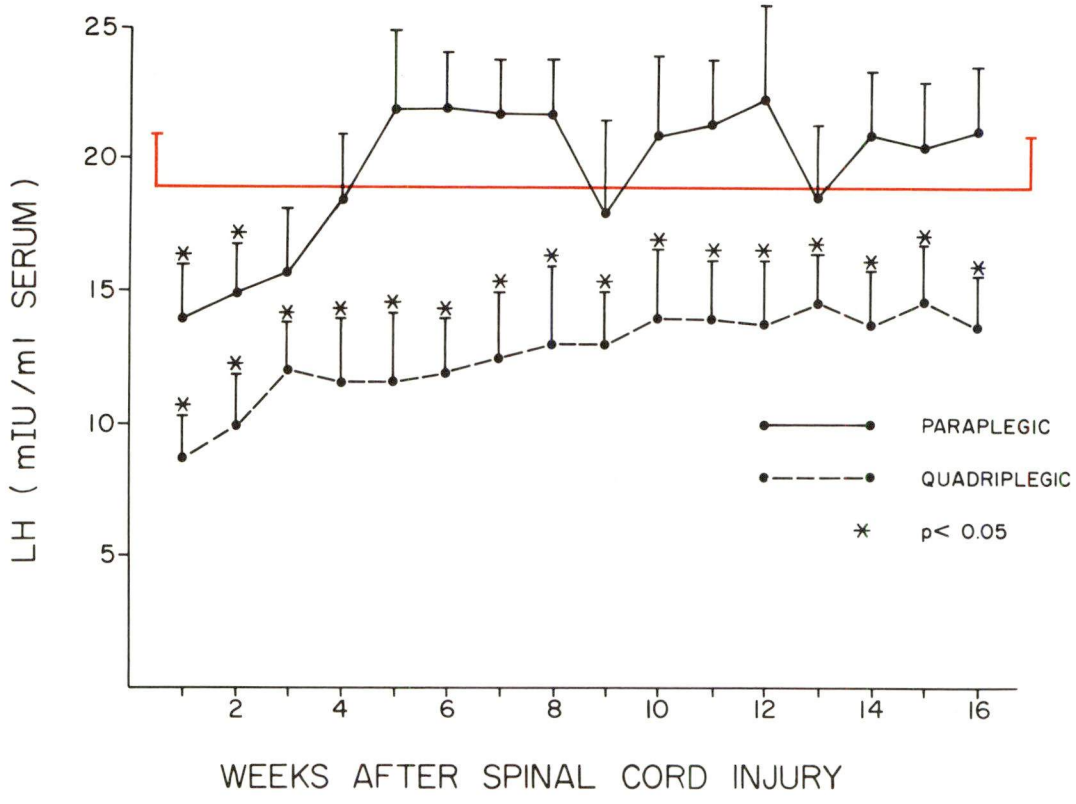
The purpose of biochemically stressing subjects is to determine the extent of remaining function, (i.e., the ability to respond to different degrees of stress). In this study, we wished to compare the response of SCI subjects to insulin induced hypoglycemia with that of controls.

Figure 5. SERUM TESTOSTERONE CONCENTRATION (Mean ± SD) OF 10 PARAPLIEGICS AND 10 QUADRIPLEGIC SUBJECTS 1 TO 16 WEEKS AFTER SPINAL CORD INJURY



NOTE: The horizontal line indicates the average serum testosterone level of 10 able-bodied control subjects.

Figure 6. SERUM LH CONCENTRATION (Mean ± SD) OF 10 PARAPLEGIC AND 10 QUADRIPLECIC SUBJECTS 1 TO 16 WEEKS AFTER SPINAL CORD INJURY



NOTE: Horizonal line indicates average serum LH livel of 10 able-bodied control subjects.

Preliminary findings of response to insulin induced hypoglycemia showed that thirty minutes after insulin administration glucose decreased by 70 percent in the controls and paraplegics but only 40 percent in quadriplegic subjects. Correlating with glucose findings, plasma epinephrine levels increased fifteenfold in the controls, five-fold in paraplegics and were unchanged in quadriplegic subjects. The peak epinephrine release came after that of hypoglycemia at 45-minutes post-insulin administration.

The results indicate a dampening of physiological and reduced hypoglycemia response in quadriplegic subjects possibly due to lower demand for glucose utilization and/or insulin receptor subsensitivity as a result of the loss of supraspinal control and curtailment of sympathetic outflow.

DYSFUNCTION OF THE AUTONOMIC NERVOUS SYSTEM

Autonomic hyperreflexia, characterized by paraxysmal hypertension, has been well documented ever since Head and Riddoch and Guttmann and Whitteridge first described the symptoms in quadriplegia. Patients with high level SCI, above the sympathetic outflow at the thoracic six dermatome (T6) level, very often develop spontaneous hypertensive crises due to any one of several noxious stimuli. These stimuli usually arise from the urinary bladder because of cystitis or kidney stone formation or from the rectum because of rectal impaction. Since quadriplegic patients are generally hypotensive, the high pressures that develop represent pressure changes of a magnitude that can cause cerebrovascular accident and death of the subject.

AUTONOMIC DYSREFLEXIA

This laboratory has published reports indicating that the neuro-transmitter released during autonomic hyperreflexia is norephinephrine. These findings provide the basis for the pharmacological treatment of the acute hypertensive crisis and for maintaining normal blood pressures in those subjects who are chronically prone to repetitive, overt and/or subclinical hypertensive episodes. Aside from pheochromocytoma, this is the first time that a causative neurotransmitter has been unequivocably identified in hypertension.[15,16]

Dopamine-B-hydroxylose (DBH) is the enzyme that synthesizes neurotransmitter norepinephrine from its precursor dopamine. Evidence has been accumulated to show that both DBH and norepinephrine are released simultaneously from sympathetic nerve endings. The activity of both DBH in serum and norepinephrine in plasma are used as indicators of sympathetic activity.

The excretion of catecholamine (norepinephrine, dopamine, and epinephrine) metabolites in 52 randomly chosen chronic SCI subjects was significantly higher than that of 36 normal control subjects. Eighteen SCI subjects were followed longitudinally for six months from the date of onset-of-injury. A long term decrease in serum DBH activity occured in quadriplegic subjects when compared with their initial level (just after the onset-of-injury). Another group of ten chronic quadriplegic subjects were kept as free as possible from conditions that would cause autonomic overactivity. Endogenous plasma norepinephrine levels in this group were also significantly lower than those of ten normal control subjects. The high excretion of catecholamine metabolites found in the first group of randomly selected SCI subjects, therefore, must be due to many subclinical, undetected autonomic dysreflexia episodes.

PLASMA RENIN AND SERUM DOPAMINE-B-HYDROXYLASE DURING ORTHOSTATIC HYPOTENSION

In order to determine whether impaired sympathetic nerve response and/or impaired renin release are responsible for orthostatic hypotension in patients with cervical spinal cord lesions, serum dopamine-B-hydroxylase (DBH) activity and plasma renin activity (PRA) were examined during passive tilting in six quadriplegic patients and in six normal control subjects. Serum DBH was measured by an isotopic enzymatic method and PRA by radioimmunoassay. Following head-up tilting, quadriplegic subjects demonstrated a prompt significant decrease in mean arterial pressure and an increase in heart rate. Dopamine-B-hydroxylase activity and PRA increased significantly in 15 minutes following tilt. In normal subjects, although heart rate increased, mean arterial pressure was unchanged and DBH and PRA did not increase significantly during head-up tilt[17]. The findings of increased DBH during tilt hypotension in quadriplegic subjects provide evidence that reflex sympathetic nerve stimulation persists despite cervical cord transection. Increased PRA may be attributed to decreased renal perfusion pressure and increased sympathetic stimulation during tilt hypotension. The significance of these data is that they suggest that orthostatic hypotension in quadriplegic patients cannot be attributed solely to the failure of the sympathetic nervous system or the renin-angiotension system to respond to the stimulus of orthostasis (erect posture).

CONCLUSIONS AND FUTURE TRENDS

Dysfunction of the endocrine and autonomic nervous system, and mineral metabolism have been studied in our laboratory in order to explain and treat the causes of the various disorders discussed. Current funding trends may preclude completing the future studies proposed below. However, we are optimistic that SCI research funding will continue in these most crucial and neglected areas.

The long term goals of our investigation of dysfunction in mineral metabolism are:

- To develop and standardize a method which measures the extent of osteoporosis in spinal cord injured subjects by computerized tomography.
- To determine longitudinally the degree of bone demineralization in patients with paralysis due to spinal cord lesion by use of computerized tomography as early as possible after the onset of SCI and once a month for three months thereafter.
- To initiate the treatment of paraplegic and quadriplegic subjects with thyrocalcitonin and diphosphonates immediately after the onset of injury in order to determine which drug is more efficacious in preventing osteoporosis and other complications such as renal and bladder stone formation and development of periarticular bone with the least amount of side effects.
- To investigate the effect of thyrocalcitonin and diphosphonate therapy on periarticular bone formation and to prevent its restrictive, debilitating effects, either by inhibiting the formation of extraskeletal bone, or once formed, causing its resorption or maturation by pharmacologic means.
- To measure the effect of dietary calcium on the amelioration or exacerbation of mineral metabolism and its related complications in animal models of SCI (rats).
- If these results demonstrate conclusively that a high calcium diet has ameliorating effects, the experiment will be extended to humans under strict dietary control.

The long term aim of our research in autonomic nervous dysfunction is to measure the effects of different levels of spinal cord injury on the metabolism of catecholamines in man and to correlate these changes with the associated degrees of impairment of neural endocrinal and cardiovascular functions. That is, to delineate the autonomic function of the spinal cord and sympathetic nervous system below the transection. The studies should be of particular importance with reference to the ability of the spinal cord injured subjects to tolerate and adapt to different types and degrees of stresses.

The investigations will involve longitudinal, repetitive measurements of the effects of different levels of SCI on:

- The concentrations of the catecholamines, serotonin, dopamine-B-hydroxylase activity, other peptide neurotransmitters, and Na^+ K^+ and Ca^{++} in the blood and cerebrospinal fluids, and the catecholamine and serotonin metabolites in the urine, in at least 100 subjects.
- The reactivity of blood vessels in the fingers to intravenously infused 1-norepinephrine in another sample of 25 subjects.
- The uptake, release, disappearance and excretion of intravenously infused labelled-norepinephrine in SCI subjects and controls.
- The cardiovascular, endocrinological, and biochemical responses to the stresses of head-up tilt, hypovolemia and insulin-induced hypoglycemia in SCI subjects and controls for each respective stress test.

The results from the above investigations and those in animal models[18, 19] will provide information about the disturbances in basic biological mechanisms caused by SCI and how they change after the onset-of-injury. It is expected that this knowledge will permit more definitive estimation of the beneficial effects of currently used methods of rehabilitation, and the logical introduction of new pharmacological agents in this process. Thus, the conclusions from our investigations may hasten the rehabilitation of spinal cord injured subjects, make it more complete and, thus, prevent relapses and re-hospitalization.

We also wish to study the neuroendocrinological functional changes in paraplegic and quadriplegic subjects. The major hormones such as ACTH, LH, FSH, TSH, vasopressin, cortisol, testosterone,

thyroxine, etc. will be analyzed in the serum of spinal cord injured subjects by the most sensitive and specific methods available. These techniques include radioimmunoassay and high pressure liquid chromatography. Immunocytochemistry will be used for localization of hormones in tissues. Thus, changes in negative feedback due to the degree of loss of supraspinal control will be measured and will be correlated with the time after the onset of SCI. Furthermore, we will investigate the adaptive mechanisms to physical (45° head-up tilting, hypovolemia) and biochemical (insulin-induced hopyglycemia) stresses and the degree of their deficiency in spinal cord injured subjects. Approximately 100 to 120 spinal cord injured subjects will be studied.

Our preliminary results on hypothalamic corticotrophic releasing hormone (CRF) and vasopressin seem to suggest that they act synergistically in the release of ACTH and that, in subjects with high level SCI, the diurnal rhythm is curtailed. The data indicate the interruption of the afferent stimuli to the brain after SCI affects the CNS control of ACTH secretion and thus the release of cortisol.

It is known that in persons with intact spinal cords, who have received drugs that reduce normal compensatory reflex sympathetic nervous system activity, that a small degree of blood loss can cause severe hypotension and suncope when supine. Although this question has not been adequately studied in spinal cord injured subjects, it must be presumed that those with high lesions are inordinately sensitive to blood loss.

The investigations of the physical and biochemical stresses in spinal cord injured humans are essential in order to identify the basic deficiencies, excesses and conditions of supersensitivity and/or subsensitivity which would result from the loss of supraspinal control and disturbance in feedback systems after SCI. The descending and ascending fibers communicating messages from the brain stem to and from the higher and lower centers mediate the usual negative feedback control of normal body functions. Once the spinal cord in transected and the feedback curtailed, the many neurophysiological dysfunctions which ensue are due to disruption of this feedback system and disturbances in the metabolism of norepinephrine, and the other neurotransmitters and neurohormones.

The results from our previous studies have delineated some of the derangements in the metabolism of these biogenic amines, disruption of other neurotransmitters and autonomic impairment of cardiovascular regulation in paraplegic and quadriplegic subjects. Similar investigations regarding the interrelationships between neural, neuroendocrinal, and cardiovascular mechanisms would seem necessary to provide the basic knowledge required for more adequate means of rehabilitating spinal cord injured patients.

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FEATURE ARTICLE

THE ROLE OF SELF-DESTRUCTION IN SPINAL CORD INJURY MORTALITY*

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As the number of individuals sustaining spinal cord injuries from violent accidents increase, we are noticing a more homogeneous patient population (1980). A clearer profile of those that do sustain traumatic injury is emerging. For more and more of these people, traumatic injury is not an isolated event. How often is it noted that the injury happens within days or weeks of a death in the family, a divorce, marriage or graduation? How often is it observed that the pre-morbid history includes drug and alcohol abuse, juvenile delinquency, chronic family problems, or *"close brushes"* with serious injury or death? During early rehabilitation, the patient himself often remarks that *"something like this was bound to happen,"* that *"it was simply a matter of time"*—in other words it was inevitable. There is a pattern here that suggests an underlying character disorder that predisposes its victims to high-risk taking, traumatic injury, and an early—avoidable—death. Unconsciously at least, the injury is but the last in a self-destructive chain of events.

There are differences of opinion over whether a distinct *"spinal cord personality"* exists. However, clinical experience indicates an emerging profile among a significant portion of the patient population. Trieschmann reported agreement among professionals that there is no unitary personality style associated with any disability, (Wright, 1960: Siller, 1969: Shontz, 1971: Cook, 1976). But Mueller (1962) and Fordyce (1964) disagree, describing the spinal cord injured person as being impulse dominated and characterized by adolescent egocentricity. Fordyce raises an important question as to how such impulsiveness exhibits itself in the rehabilitation process. How do pre-morbid personality features affect the self-care regimen which is so critical following spinal cord injury?

Most chronic disabilities require close attention: spinal cord injury demands constant vigilance by the patient. There is no doubt that many medical complications associated with the injury can be prevented. In this respect, patients who adhere to medical advice can lessen the chances of pneumonia, decubitus ulcers, and urinary tract infection. In many cases they can be avoided completely.

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However, individuals who are impulsive demonstrate a poor capacity to take care of themselves and to accept responsibility (Wishnie, 1977). It is for this reason that a significant number of hospitalizations are for complications that could have been avoided. The inability to accept responsibility for self-care is the continuation of a pattern that existed long before the injury itself. It is an integral feature of the character disordered individual. In such persons, avoidable complications reflect an underlying psychological process and are defined as indirect suicidal behavior. They are self-defeating and hasten death.

Self-destructive behavior is easily disguised in the ongoing medical complications that are so common in the spinal cord injured. It can be seen in the patient who develops pneumonia shortly after discharge or the patient who is continually plagued with chronic decubitus ulcers. We recognize that a significant number of patients develop complications in spite of our best efforts while other patients will go for years without requiring additional hospitalizations. These habitual complications, regardless of their medical etiology, demonstrate a propensity toward self-neglect and irresponsibility. The end-result is always the same: the health and medical well-being of the individual is compromised.

In the so called able-bodied population, indirect suicide includes such behavior as smoking, alcohol or drug abuse, poor nutrition and careless driving. Among the spinal cord injured, indirect suicide manifests itself as decubitus ulcers, pneumonia, inattention to bladder function or an overreliance on medication. Its destructiveness proceeds slowly and gradually over a prolonged period of time. The self-neglect and psychological process may be vaguely observable or hidden completely. This behavior is long range and may span a period of years so that ultimately death may appear to be completely unrelated to any overt behavior. This is not suicide as we know it in our present terminology.

Suicide is the extreme form of self-destructive behavior. In contrast, indirect self-destructive behavior is defined as behavior where self-injury is not the primary conscious goal, but instead is an undesired effect (Litman, 1980). Indirect suicide was described in the last century by Durkheim (1897) as the exaggerated form of common practices.

In more recent literature, the concept has been discussed under a variety of names and descriptions. Nyquist and Bors (1967) describe such behavior as *"physiological suicide"* wherein eventual death is accompanied by neglect or failure to take care of bodily functions. Jackson (1957) describes this behavior as *"partial suicide"* and attributes it to accident proneness or chronic complaints of illness. Although this behavior is life threatening, it is a style of coping that is mastered early in childhood. During early years, we all "learn" what defenses work best and how to cope with stress. Once we "unconsciously learn" how to cope with stress, we continue that pattern throughout adulthood. For some, talking about feelings can reduce anxiety. For others, coping mechanisms are action oriented and are behavioral rather than verbal.

These behaviorally oriented people are notable in our spinal cord injury units. They have used behavior in their attempts to avoid painful feelings usually stemming from issues of separation or loss. In times of stress, automobiles and motorcycles provide a means of avoiding or escaping a painful reality. For those who are chronically depressed prior to injury, their high-risk behavior has become a deeply ingrained method of warding off the pain of depression. It is not the paralysis itself which leads to self-destructive behavior (Seymour 1955). This defense style was established early in life. The injury is but another crisis which demands a re-mobilization of the individual's personal defense patterns.

> The following case illustrates this process: TS is a 52-year old male who sustained a T12 complete lesion approximately twenty-two years ago. Since his injury, he has continually developed decubitus ulcers which have required frequent hospital admissions and corrective surgery. His hospitalizations have occurred with

such frequency that they have prevented him from seeking employment or leading an active life. His alcohol consumption increased markedly after his injury and he seldom left the safety of his home. He was not sexually active and with chronic marital stress, he eventually became divorced and was forced to give up his home. When a psychotic episode followed this loss, he became engaged in psychotherapy and was followed regularly as an outpatient.

The history revealed that he came from a home that included an overprotective mother and a father who was not emotionally available to him. He began drinking heavily at age 14. His adolescence was characterized by promiscuity and delinquent behavior. He was married immediately following discharge from the army at age 21.

Two days following the birth of his first child, while employed as a tree surgeon, he fell 30 feet sustaining the injury that left him a paraplegic. He was never able to discuss the injury with his wife, and harbored feelings that he was only half a man. His medical condition paralleled the instability of his emotional health.

Because he had never learned to accept responsibility prior to his injury, he could not do so afterwards. He struggled with his sense of inadequacy by drinking and neglecting his medical needs. This gave him a false sense of control as well as a means of avoiding the intolerable pain brought on by his sense of loss. Self-neglect provided him with a means of maintaining this denial. The predisposition toward acting out had been established early in life and had always been his characteristic style of coping. It had also put him in danger.

Self-neglect or indirect suicide is a common phenomenon which has been cited frequently in the rehabilitation literature. Comarr (1965) describes a case of self-induced ischiectomy in a spinal cord injured person due to prolonged sitting. Price (1973) describes three individuals in whom self-neglect appeared to be the contributing cause of death: renal failure after developing pneumonia; septicemic shock secondary to urinary tract infection; and, decubitus ulcers which resulted in osteomyelitis. Price concludes that emotional issues are influential in the cause of death in six of eleven patients.

In a follow-up study of 423 consecutive patients admitted to the Spinal Cord Center at Rancho Los Amigos Hospital, Wilcox and Stauffer (1972) state that 34 percent of the deaths were probably avoidable. Conditions considered to be closely associated with the disability (including overdoses of drugs and alcohol, multiple pressure sores and other forms of suicide) accounted for 17 of 50 known deaths.

Reliable statistics on self-neglect among spinal cord injured persons are difficult to obtain. Nevertheless, Bors (1956) has studied indirect suicide as it applies to paraplegics and quadriplegics. He reports that physiologic suicide was absent in quadriplegics while it caused as many as 28 percent of 60 fatalities in paraplegics. Noting the high incidence of self-neglect in paraplegics, Wright (1960) has postulated that there is a difference in expectations that the paraplegic places upon himself in contrast to the quadriplegic. The paraplegic places greater demands on himself to maintain his pre-morbid self-image. In his attempts to minimize his sense of loss, the paraplegic feels a greater urgency to keep up with his peers and former lifestyle. These are the workings of what has been termed, *"the ego ideal"*.

To better understand the concept of indirect suicide, it was felt that a current mortality survey might give further insight into this phenomenon. Survival rates and causes of death were then examined for the 4,512 patients currently registered with the National Spinal Cord Injury Data Research Center (NSCIDRC). These patients constitute the total number reported to the NSCIDRC in Phoenix, Arizona, as of July 16, 1980.

A total of 289 deaths were reported by the 14 Regional Spinal Cord Injury Systems that comprise the Model Systems' network. One hundred and thirty-one deaths (49 percent) occured prior to discharge from initial hospitalization and rehabilitation (Table I, Figure 1). From the time of discharge to the sixth-year follow-up, an additional 158 deaths (55 percent) were reported. The current mortality rate following spinal cord injury is 6.4 percent.

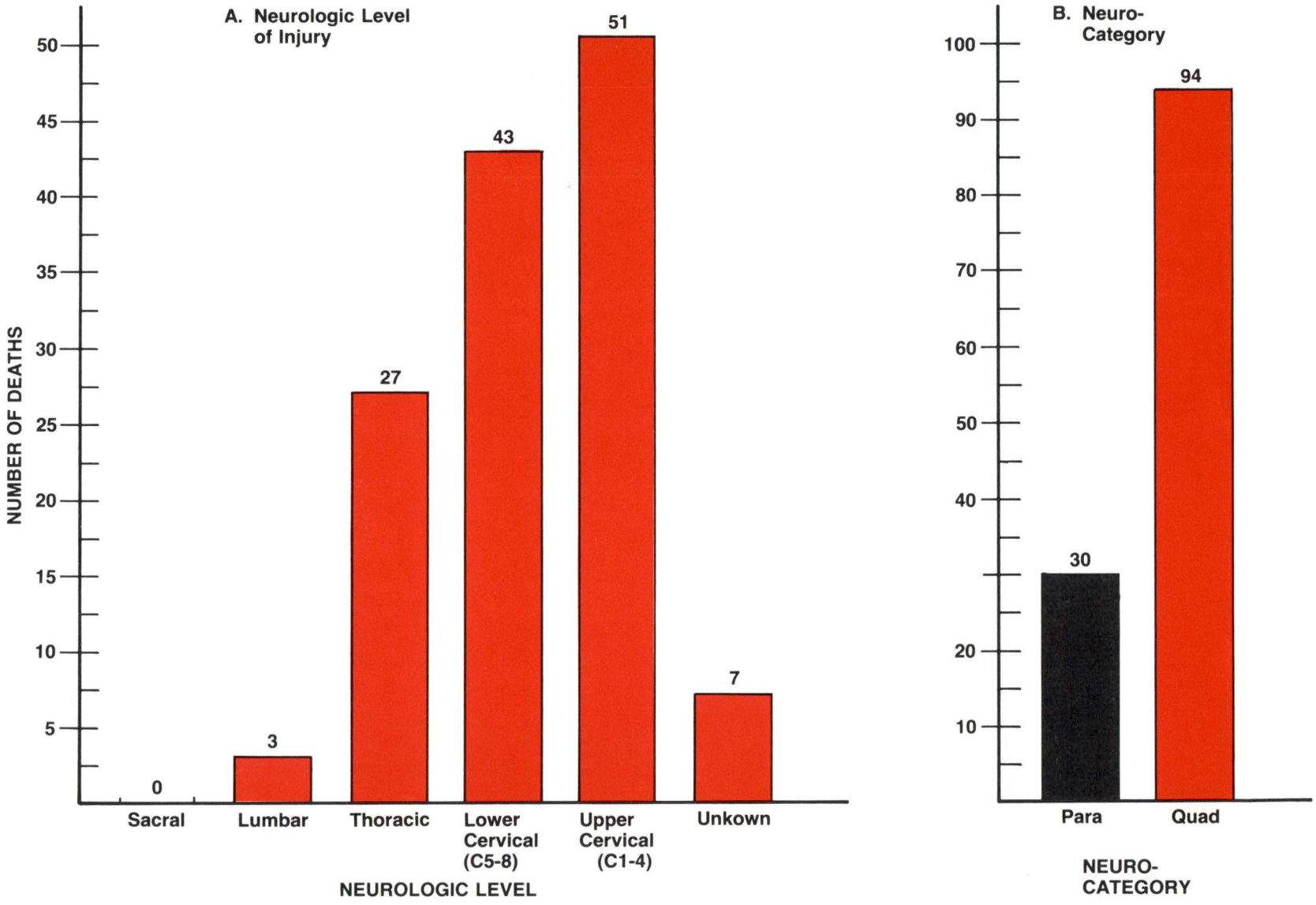
More than 50 percent of the 158 follow-up patients were either unknown to the SCI Center at the time of death, or insufficient information was available to make a proper judgement as to the causes of death. This high number of "lost" patients raises questions concerning their psychological condition. It may be surmised that these patients had sought medical attention in a facility not within the Model Systems' network. However, it is certainly plausible that severe depression, despair or suicidal ideation may have determined whether a patient left the System. Maintenance of System Follow-Up involves, on the part of the patient, active participation and responsibility for providing information to the reporting Center. Severing contact, on the other hand, may represent a passive refusal of ongoing medical and psychological support.

Nine percent of the 158 deaths that occurred during the six follow-up years were apparent suicides. Eighty percent of these suicides occurred during the first three follow-up years. (Interestingly enough, males accounted for 84 percent of these deaths: they also account for 84 percent of all injuries sustained.) Four out of five of the apparent suicides sustained spinal injuries as a result of a motorcycle accident, while one third had suffered other motor vehicle accidents or gunshot wounds. It may be difficult to assign responsibility for the cause of injury, but it is interesting to note that these people did not appear to be passive bystanders.

Table 1. INITIAL HOSPITAL PERIOD: CAUSES OF 131 PATIENT DEATHS

	PATIENT DEATHS	
CAUSE OF DEATH	**N**	**TOTAL**
CARDIOVASCULAR:		
Pulmonary Embolism	20	
Myocardial Infarction	5	
Cerebral Hemorrhage	2	
Unspecified Circulatory Disease	2	
Cerebral Thrombosis	1	
Aortic Aneurysm	1	
Unspecified Aneurysm	1	
Acute Heart Failure	1	
Ischemic Heart Disease	1	34
RESPIRATORY:		
Pneumonia	23	
Pulmonary Edema	2	
Unspecified Respiratory Disease	2	
Upper Respiratory Infection	1	28
SEPTICEMIA		7
PERFORATED PEPTIC ULCER		6
CENTRAL NERVOUS SYSTEM:		
Unspecified Brain Disease	1	
Intracranial Injury	1	
Encephalitis	1	3
KIDNEY:		
Acute Tubular Necrosis	2	
Unspecified Renal Disease	1	3
PANCREATIC DISEASE		2
OTHER:		
Meningitis	2	
Unspecified Liver Disease	1	
Foreign Body in Bronchus or Lung	1	
Hematemesis	1	
Shock	1	
Post-op Hemorrhage with Toxic Effect of Beryllium	1	7
UNKNOWN OR POORLY DEFINED		41
	Total Deaths	131

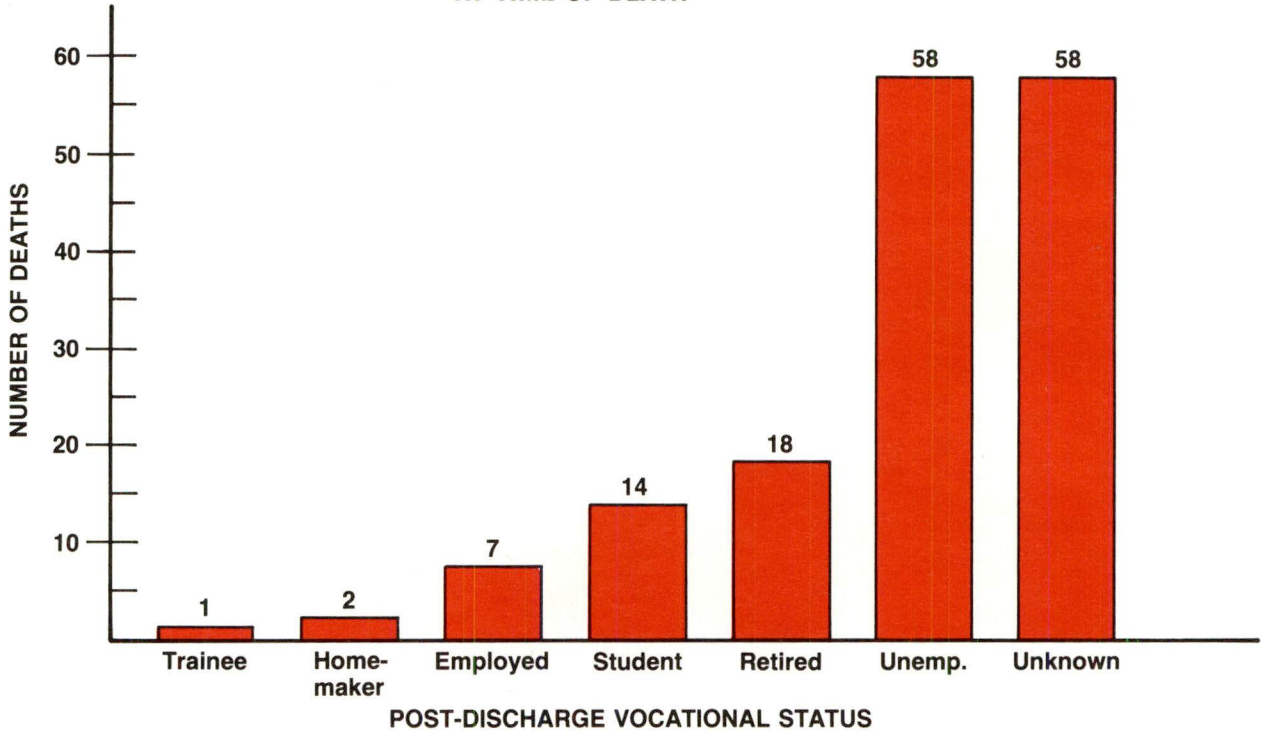
Figure 1. DEATHS DURING INITIAL HOSPITAL PERIOD



It may be anticipated that patients with the most severe injuries would be most likely to commit suicide. This is not the case. Paraplegics, rather than quadriplegics accounted for 73 percent of the suicides. Nyquist (1967) also found this inverse relationship between suicide and severity of injury in his study of patients at the Long Beach Veterans Administration Hospital. Wright (1960), in explaining the phenomenon, noted that the nearer the disabled is to the able-bodied, the more difficult the adjustment because of the increased demands to compete with the able-bodied population. Moreover, Hopkins (1971) suggested that the care and observation necessary for quadriplegics after discharge may lower suicide rates. If suicidal ideation were present among quadriplegics, it would manifest itself through indirect means, that is, through gradual self-neglect.

For 58 of the 158 patients who died in the follow-up years, little was known about their educational or occupational status at the time of death. Of the remaining 100 patients, whose status was known at the time of death, 76 percent were either unemployed or retired. The remainder fell within the categories of employed, student or homemaker, (Figure 2).

Figure 2. DEATHS DURING HOME FOLLOW-UP YEARS 1–8: PRIMARY OCCUPATIONAL, EDUCATIONAL, OR TRAINING STATUS AT TIME OF DEATH



Although occupation or employment should not be considered the only variable in an operational definition of adjustment, it is a helpful barometer in understanding an individual's lifestyle. For example, impulsive personalities have chronically unstable educational and employment histories (Reiner and Kaufman, 1959). Work not only reflects values and goals, but has significance in such areas as social skills, interpersonal relationships, independence and self-esteem. Successful life adjustment is not only associated with a lack of medical complications but is also reflected in the utilization of daily living skills activities and productivity after injury, (Trieschmann 1974, 1978).

The propensity for self-neglect is a matter of individual interpretation when examining causes of death in follow-up patients, (Table 2, Figure 3). One wonders how many patients die because of

Figure 3. DEATHS DURING FOLLOW-UP YEARS 1–6: BY FOLLOW-UP YEAR AND INITIAL NEURO-CATEGORY

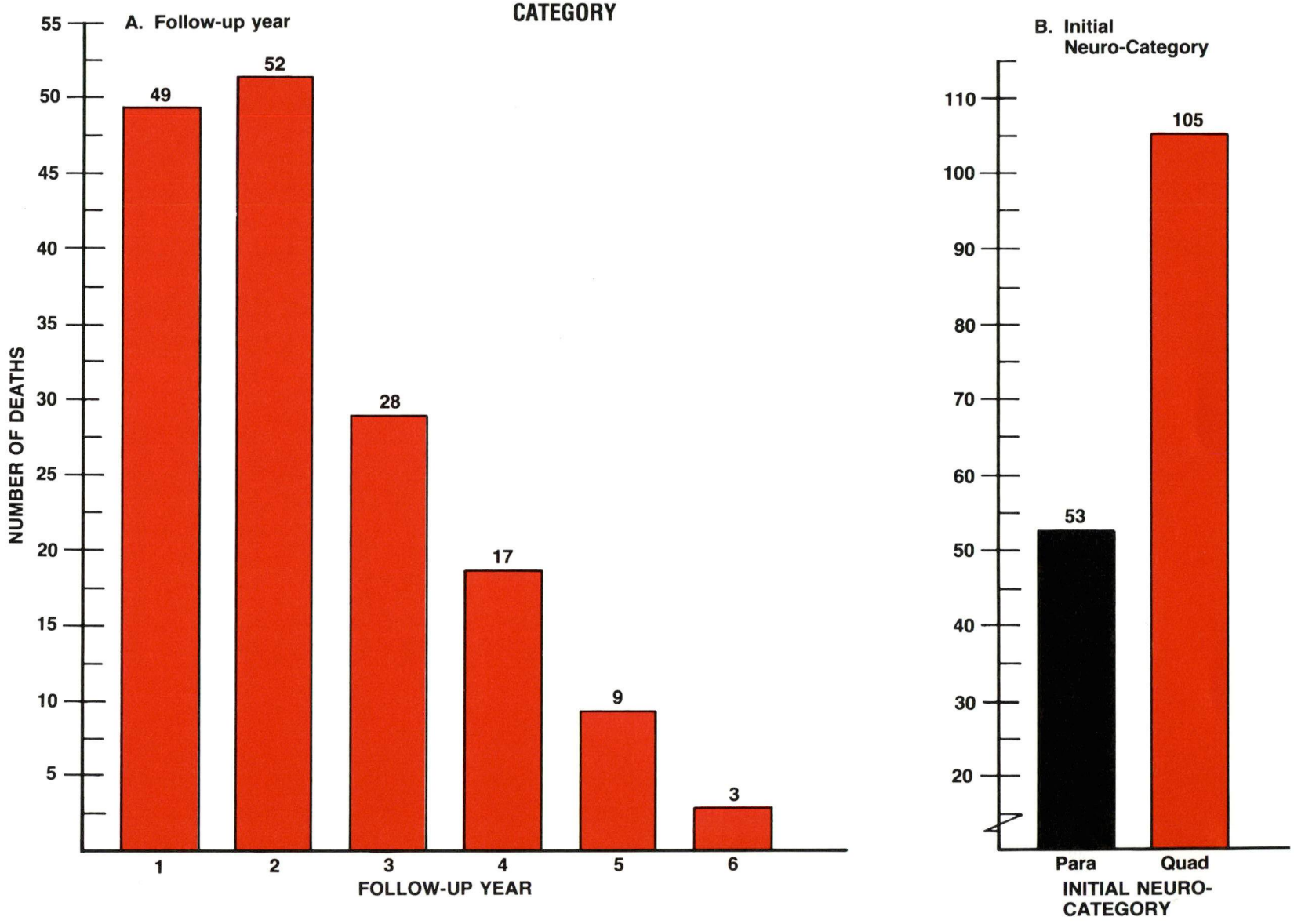


Table 2. FOLLOW-UP YEARS 1–6: CAUSE OF 158 PATIENT DEATHS

CAUSE OF DEATH	PATIENT DEATHS N	TOTAL
RESPIRATORY:		
Pneumonia	24	
Pulmonary Congestion	3	
Influenza	1	28
CARDIOVASCULAR:		
Cerebral Vascular Accident	8	
Myocardial Infarction	4	
Unspecified Heart Disease	2	
Congestive Heart Failure	1	
Acute Heart Failure	1	
Acute Pericarditis	1	17
CARCINOMA		13
EMBOLISM:		
Pulmonary	6	
Arterial	1	7
RENAL DISEASE:		
Unspecified Renal Disease	4	
Acute Nephritis	3	7
SEPTICEMIA		5
OTHER:		
Infectious Hepatitis	1	
Gastric Obstruction	1	
Foreign Body in Pharynx	1	
Head Injury—No Open Wound	1	
Injury to Liver 2° to MVA	1	5
POSSIBLE SUICIDE/NEGLECT:		
Multiple Open Wounds	1	
Injury to Unspecified Site	2	
Open Intracranial Wound—Gunshot, Suicide	1	
Exposure	1	
Toxic Effects of Gas or Noxious Fumes	1	
Drowning	2	
Open Chest Wound	2	
Adverse Effect, Drugs	3	
Open Wound Head, Neck, or Trunk/Traumatic Aneurysm	1	
Open Wound, Lung—Gunshot, Suicide	1	15
UNKNOWN OR POORLY DEFINED:		
Patient Unknown to SCI Center At Time of Death	47	
Ill-Defined or Unspecified Cause	7	
Sudden Death, Cause Unknown	2	
Cardiac Arrest (Not Otherwise Specified)	5	61
	Total Deaths	158

preventable pneumonias, or whether decubitus ulcers need to progress to sepsis or other severe complications? Certainly, if patients act in a responsible manner, the incidence of death from self-neglect should be minimal.

For the clinician in rehabilitation, pre-morbid histories and coping styles have strong implications. They provide a valuable insight on treatment modalities and potential problems. In spite of the intensity of their emotions, patients have great difficulty discussing or verbalizing their feelings. Their way of communicating is through actions. It is our responsibility to guide them in learning new ways of coping that utilize speech rather than actions or physical symptoms.

We must relate to these patients in a supportive and direct manner. By allowing them to overcome their mistrust of others, we can begin to set the framework for less drastic and less dangerous coping styles. Early patterns of behavior can be changed although it requires time, support and consistency. It also requires limit setting, which we may find far more difficult.

Most importantly, our understanding of medical complications needs to take full cognizance of the psychological processes at work. We need to recognize self-neglect as an ineffective struggle with overwhelming anxiety. It should be a signal to us that the propensity for self-destruction may exist and appropriate action is needed.

DATA SOURCE

Previously unpublished data—presented herein—were provided by the National Spinal Cord Injury Model Systems Project, (1980) (sponsored in part by the National Institute for Handicapped Research) by the following Projects: University of Alabama Regional Spinal Cord Injury System, University of Alabama in Birmingham, Birmingham, Alabama; Southwest Regional System for Treatment of Spinal Injury, Good Samaritan Hospital/St. Joseph's Hospital, Phoenix, Arizona; Northern California Regional Spinal Injury System, Santa Clara Valley Medical Center, San Jose, California; Southern California Regional Spinal Cord Injury System, Rancho Los Amigos Hospital, Downey, California; Rocky Mountain Regional Spinal Cord Injury System, Craig Hospital, Englewood, Colorado; South Florida Regional Spinal Cord Injury System, University of Miami School of Medicine, Miami, Florida; Midwest Regional Spinal Cord Injury Care System, Northwestern University, McGaw Medical Center, Chicago, Illinois; New England Regional Spinal Cord Injury System of University Hospital, Boston University Medical Center, Boston, Massachusetts; Missouri Regional Spinal Cord Injury System, University of Missouri School of Medicine, Columbia, Missouri; New York Regional Spinal Cord Injury System, Institute of Rehabilitation Medicine, New York University, New York, New York; Regional Spinal Cord Injury System of Delaware Valley, Thomas Jefferson University, Philadelphia, Pennsylvania; Texas Regional Spinal Cord Injury System, The Institute of Rehabilitation and Research, Houston, Texas; Virginia Regional Spinal Cord Injury System, Woodrow Wilson Rehabilitation Center, University of Virginia, Fishersville/Charlottesville, Virginia; Northwest Regional Spinal Cord Injury System, University of Washington, Seattle, Washington.

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Psychosocial . . . *(continued from page 6)*

to comprehending the thoughts, feelings, and behavior of post spinal cord injured individuals if we understand Erikson's eight stages of life and how they apply to the process the injured person undergoes for a considerable time post-injury.

ERIKSON'S EIGHT STAGES OF LIFE

Because of the importance of Erikson's analysis, therefore, his eight stages are paraphrased in the following sections. Typical chronological time spans are given for each stage though each individual, of course, will progress at his own rate.

TRUST (0 to 18 months)

The first stage, which occurs in infancy, is described as the stage of *trust* versus *mistrust.* Erikson's argument is that the development of the infant's sense of trust or mistrust with respect to himself and his environment is a consequence of what he or she experiences during this period. The

important factor is the quality and not the quantity of treatment. The sense of trust comes from a feeling of inner goodness derived from the mutual regulation of the infant's receptive capabilities with the maternal techniques of providing care. When the Mother, who is the "significant other" at this time, gives a quality of care that transmits a sense of trustworthiness and meaning, then the infant develops a corresponding sense of trust. If the infant's care is filled with discontinuities, however, the baby may feel lost. Recognizing his separateness from his Mother, he may develop a sense of mistrust that can last throughout life. (During this first stage of development, the infant appears to be totally egocentric, behaving as if he were all that existed and counted.)

AUTONOMY (18 months into third year)

The second stage, early childhood, typically begins around the age of eighteen months and goes into the third year of life. In this stage, the strife is between a developing sense of autonomy and of shame and doubt. When the child begins to gain muscular control, he starts to experiment with "holding-on" and "letting-go." He starts to cut apron strings. The child begins attaching an enormous value to his autonomous will. The danger here is the development of a deep sense of shame and doubt. If the child is deprived of the opportunity to develop in an autonomous way, he will learn to expect *defeat* in any battle of will with those who are bigger and stronger. During this stage, society begins to have more influence on the individual. The "holding-on and letting-go" brings the individual into direct conflict with his society.

The child learns to use operants at this stage. He learns to get somebody to do something for him, and he learns to give. During this stage, we see a broader influence of the people around him. The Father and other significant adults will start to take a more active part in the child's development. Toward the end of this stage the child is convinced that he is a person on his own.

INITIATIVE (3 to 6 years)

The next stage, which Erikson calls the "play age," is that in which the basic conflict is between a developing sense of initiative and of guilt. The child's imagination is greatly expanded in this stage. He learns to move around more freely (and more violently) and to establish a wider range of goals. He asks many questions, because his language is now capable of forming them, and expands his imagination. The main outcome of this stage is the development of a sense of purpose. This is when we begin to see many differences resulting from the impact of society, a time when children start to respond differently with respect to their own sexuality. The play of the male takes on a more intrusive, outgoing exterior, for example, whereas the play of the female begins to be more concerned with the interior of spaces. (Erikson, 1975, clarifies misinterpretations by other authors about womanhood—his basic contention is that anatomy "to some extent, determines cultural conditioning.")

INDUSTRY (6 years to puberty)

The fourth stage Erikson calls the school age—the development of a sense of industry versus inferiority. This stage starts somewhere around the first grade and continues into adolescence—probably to the age of eleven or twelve. This is when the child wants to learn how to do and make things with others. He learns to accept instruction and to win recognition by producing things.

IDENTITY (Adolescence)

The fifth stage, which comes with the physiological changes that takes place during adolescence, is that of identity. Because of his own rapid body growth and sexual maturity, the adolescent begins questioning the continuities that he relied on earlier in life. He usually ends up re-fighting many of the so-called battles that he fought to reach this stage. The tasks which the adolescent faces are concentrated around the integration of his childhood identification with the basic biological changes of puberty, and the opportunities that are offered him in terms of the roles he will play in school and elsewhere in society.

Erikson states that identity diffusion (which is reflected by confusion about the status of one's own personal and social milieu) is temporarily unavoidable at this particular time but may result in a permanent inability to grasp and hold to one identity. Sometimes we see a negative identity develop when the adolescent strives to be the opposite of what his significant others want him to be. This stage is a very crucial one and certainly contigent upon what has gone on up to this point in the person's development. Basically, if he is to achieve an "identity," a complimentary relationship between his needs and capacities and his society's rewards and demands has to take place. If such a relationship develops, then the image derived from these two factors—the individual and society—will be the kind of tentative identity that the person will strive to perfect.

INTIMACY (Young adulthood)

In the sixth stage, that of young adulthood, the individual develops a sense of intimacy versus a sense of isolation. This comes about if, during the stage of identity crisis, the person has established intimacy with himself and with his inner life. Henceforth, he can start to share that identity with another person and with the world of work. A person who cannot enter totally into an intimate relationship due to the fear of losing his identity may develop a deep sense of isolation in which he will shun loving and trusting others.

GENERATIVITY (Adulthood)

The seventh stage is the stage of adulthood, wherein the individual strives to develop a sense of generativity and avoid a sense of self-absorption. Generativity is displayed when the mature person is engaged in activities which foster positive growth of future generations. The lack of this sort of involvement results in self-absorption, and the person will often feel as though he is not progressing at all and will not experience the positive outcomes of interpersonal interaction.

INTEGRITY (Maturity)

In the final stage, a sense of integrity builds on the achievement of earlier stages—intimacy with other human beings and generativity activity. The person in this stage assumes the responsibility for his life accomplishment and for the way his life is interfaced in a historical sense. His successful passage through the prior stages and his retrospective looks at past accomplishments enable him to look to the future with hope. This developed sense of ego integrity enables the fully mature individual to avoid the despair of less mature individuals.

PSYCHOSOCIAL REDEVELOPMENT

A quotation from Erikson is relevant here: "Healthy personality must reconquer them (the past stages) continuously in the same way that the body's metabolism resists decay."[1] This so-called redevelopment takes place for ablebodied people going through ordinary life development. Think of the severity, the intensity, the psychosocial trauma that is present when a person starts to reprocess these stages after the intense body changes brought about by spinal cord injury. Again, a quotation from Erikson: "Nurses have observed that any adult who undergoes serious surgery has to repeat the battle with these nemeses in the process of recovery."[2]

INFLUENCE OF ALLIED HEALTH PROFESSIONALS

As we have reviewed Erikson's stages, some of the highlights of our own development have surely been displayed and, in considering these highlights, we most likely have feelings of accomplishment in some areas and in other areas, little if any. All of us have feelings of hope, we all to some degree have a will, a purpose, a realization of fidelity—these are elements of ourselves. Erikson says that successful identity achievement results in that state "Wherein we can experience progressive

1. Page 43 from "Youth and the Life Cycle." Children, March–April, 1960, 7.
2. ibid, Page 8.

continuity between that which we have come to be during the long years of childhood and that which we promise to become in the anticipated future; between that which we conceive ourselves to be and that which we perceive others to see in us and to expect of us."[3]

The professional who understands his own development in Erikson's terms and who is able to see a parallel between his own development and the stages through which the spinal cord injured patient progresses will be much more likely to exert a positive influence. The professional's self-understanding—his recognition that we all develop through these stages—will allow him to feel and to express sympathy and empathy without showing pity and without losing his professional objectivity.

To some degree, the feelings of mistrust, guilt, shame, inferiority, despair, and isolation will be experienced many times after the spinal cord is damaged. When the injured person awakens in the recovery room or during the acute treatment and starts to realize that he has no feeling and that function is limited, then all of the positive sides of the polar steps (within the several stages of development) are called into question. Like the typical adolescent but with more intensity and more sudden onset, the victim has a different body. The degree of continuity which existed in his *able body* is not there. The mutual continuity with respect to society is not there.

ACUTE TREATMENT ENVIRONMENT

When a person is in the acute treatment environment, he is surrounded by friends, family and doctors. The victim is shocked, confused and worried, and he experiences unpleasant excitement along with discomfort. Those persons who surround him also experience discomfort, excitement, worry, and sometimes confusion.

These outside factors or aspects of this particular individual's immediate environment contribute to his identity diffusion. Not only does the spinal cord injured person have inconsistencies within his body but he also experiences inconsistencies with respect to the environment. There is a great disparity between the present environment and his environment before injury, not only physically but also psychosocially.

The total environmental impact brings about a psychosocial regression in the individual's development which necessitates the reprocessing of more stable components of identity. The negative side of the stages are strengthened and place the post-injury psychological status in a precarious predicament. Think about how the spinal cord injured person reacts if he feels like a sandwich every time he is turned. By necessity the staff has to clamp down the two sides of the apparatus and flop him over. He is at the mercy of those who care for him; he is in their control; *he is helpless.* Patients have told us that they feel like the meat between two slices of bread at this stage. The helping professional has the opportunity to amplify or diminish these feelings; to enhance positive identity formation or to create negative outcomes.

ACCEPTABLE IDENTITY OF DISABLED BODY

Critical psychosocial reprocessing of time perspective versus time diffusion; self certainty versus apathy; role experimentation versus negative identity; anticipation of achievement versus work paralysis; sexual identity versus bisexual diffusion leadership; polarization versus authority diffusion; and idealogical polarization versus diffusion of ideals must take place so that the person can create an acceptable identity.

To regain the balance in a positive direction means a development of trust, autonomy, initiative, industry, and identity, versus mistrust, shame, guilt, inferiority, and diffusion. This psychosocial

3. From Maier, H. W. "The Theories of Child Development," Page 67–68, quoted from Fredrich (Ed.) Totalitarionism, Cambridge, Mass., Harvard Press, Page 165.

herculean task calls for an extremely well planned treatment and rehabilitation environment. Certainly, the individual can start to *trust* the treatment environment if the professionals therein are consistent, and if they give clear explanations as to what is *expected* and what can be the positive outcomes for spinal cord injured individuals. Experiences of *outward consistencies*—via the interaction between persons and the physical environment—can be one of the primary factors in the spinal cord injured person's re-establishment of the *internal consistencies.* Only if the treatment environment is appropriate will the patient be able to reprocess the other stages of redevelopment in a realistic time span.

SENSE OF INDEPENDENCE

A well planned and early developed bowel program, and a reliable bladder training program commenced during the beginning of the rehabilitation phase can initiate a sense of independence: a *sense of autonomy,* so that the patient does not have to dwell on shame and doubt. If he does not control his bowels, then shame may overcome autonomy; if he has to be concerned about blowing a texan, the doubt may give rise to considerable emphasis at this crisis. Success at physical and physiological tasks can blend into success at social reconditioning. A night out with others—with a consistent control of bodily functions—can lead to the kind of self certainty which fosters greater interactions in the future.

A sensitive therapist can assist the individual in experiencing some initiative. Initiative is increased with gains in movement—the trying out of his body after it has been differentiated from that of the treatment professionals (which is an expression similar to the young child cutting the apron strings). This gain in initiative can help to maintain the balance of development in a positive direction. The autonomous body can be put into use to explore what is possible. The spinal cord injured individual can under these conditions, redefine his roles and anticipate achievement.

Subsequently, the spinal cord injured person can make and do things, can do wheelies, can progress and develop his skills. He can start to think of what it means in terms of his sexual identity if he lets go of the ablebodied image and starts to think in terms of the disabled body image, and what this change might give him in terms of sharing with another and in terms of an occupation. The critical reprocessing of the identity crisis can ultimately result in some degree of comfort that can be experienced in the disabled body, and more broadly in terms of the three things we addressed earlier in this paper that are necessary for maturity. As Erikson puts it: "The reconciliation of genital orgasm and extra genital sexual needs; the reconciliation of love and sexuality; the reconciliation of sexual procreation and work productive patterns."[4] These are the factors that are going to be at the heart of the identity crisis in the spinal cord injured invididual. No doubt the individual will mull these questions: How do I deal with the body? How do I share my total self with others? How do I deal with the products of procreation and work?

RETURN TO THE COMMUNITY

Finally, it should be noted that when the spinal cord injured person returns to the community, his battered ego will need continued support to gain an acceptable representation of itself and of its successive identification with other persons and their responses and appraisals. At this point, the individual is actively reprocessing those issues which he experienced in the treatment environment; those issues in the rehabilitation environment; those issues of his significant others. In leaving the hospital and rehabilitation environment, however, he leaves part of his newly developed security—the intensity is higher than at previous rehabilitation stages.

Psychosocial professionals should be aware that when the spinal cord injured person confronts the *in vivo* realities of his community, he is leaving an environment (hospital and rehabilitation) which was controlled and which aided him in coming to terms with his new image of himself as disabled. He is returning to an environment which is not controlled and in which he last functioned

4. Erikson, Erik (1975), page 4.

as ablebodied. Therefore, the stages—trust, autonomy, initiative, and so forth—through which he has passed *must be further reprocessed.*

CONCLUSION

These theoretical formulations are supported by recent results from a very intensive and extensive project being carried out under the research program of the National Institute for Handicapped Research, at six locations across the country. These results are cited by Thompson et al (1980). Briefly, responses on the MMPI, the Locus of Control, the Multiple Affect Adjective Check List, the Human Service Scale, and several other instruments describe our Eriksonian reformulations. We anticipate that the results from the completion of the four year follow-along study mentioned above will further detail these theoretical formulations and offer a model of interventive strategies.

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Housing	2/3/4
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	2/3/5
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SEX	
Distribution	1/1/13
Etiology	1/1/13
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Role	2/3/6
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TOPIC	VIP*
Questions/Answers	1/1/11
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Re-Hosp: Years 2/3	1/4/21
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From the Data Bank . . . *(continued from page 2)*

their neurological functions. Within reason, the medical-rehabilitation team must do what it can to help these severely injured persons survive and to make survival meaningful.

It is true that advances create additional problems. But, problems create challenges. Challenges stimulate effort and effort produces solutions. The cycle goes on and on.

What are some of the challenges. Obviously, the catastrophy of spinal cord injury with its life-long consequences demands major efforts in prevention. Community awareness programs are not futile. Their effectiveness is difficult to document in that, with the low incidence of spinal cord injury, good statistical data is unavailable to establish what would have happened without an organized prevention program. All of the Regional Spinal Cord Injury Systems have intensified their efforts to acquaint people in their communities with the causes and consequences of spinal cord injury. Unquestionably, with broader application of such programs, we can reduce the incidence of traumatic spinal cord injury in the United States.

While it is unquestionably true that better Emergency Medical Services have increased the number of surviving high quadriplegics, it must be remembered that it has also produced another phenomena. Fifty percent of all traumatic cases survive the initial injury with preservation of some neurological function. What happens in the first few hours following injury can have a major effect on how much function ultimately survives. It may be a little or a lot. It may be the difference between whether the injured persons wiggles his big toe or walks. The degree of preservation of residual spinal cord function can be markedly influenced, for better or worse, by the skill or lack thereof of the initial emergency evacuation-trauma team.

STATUS OF NATIONAL DATA BANK
(as of Dec. 24, 1980)

	ENTRIES TO DATE	
INJURY YEAR (FORM I)		
1973	223	
1974	428	
1975	622	
1976	713	
1977	849	
1978	884	
1979	929	
1980	302	4950
FOLLOW-UP YEAR (FORM II)		
Year 1	3275	
Year 2	2555	
Year 3	1858	
Year 4	1160	
Year 5	650	
Year 6	296	
Year 7	112	9906

A third area of challenge is definitive medical and surgical management of the acute injury. Realistically, we will never be able to effect the course of paralysis in the severe injury that macerates the spinal cord over several segments. However, we must remember that half of the persons with spinal cord injury have incomplete injuries. Basic research has established that considerable damage to the cord occurs as a result of metabolic disturbances at the injury site *after the injury*! Through research, we are beginning to identify these mechanisms and develop measures for inhibiting or modifying them. Perhaps, in the foreseeable future, we will have tools to prevent a major proportion of the secondary damage that occurs after the initial injury.

Unquestionably, we can reduce the occurrence and minimize the degree of permanent paralysis with community education and scientific research. There is a further challenge. We are beginning to question a basic tennant: "The spinal cord in the human cannot regenerate itself." A major and increasing research effort is being made to understand the mechanisms of neuronal degeneration and regeneration in the central nervous systems. The complexity of the subject is almost overwhelming but not completely. Bit by bit the Gordian knot is being unraveled. We will never "cure" traumatic spinal cord injury in the sense that we "cured" polio. As a matter of fact, we were never able to cure the paralysis of polio once it occurred. Immunization only prevented the occurrence. However the day may come when we will have techniques to establish neural continuity between the distal and proximal stumps of the damaged cord with a resultant improvement in the degree of paralysis and loss of sensation below the injury. Who is to say such things are impossible. We will never know until we try.

. . . John S. Young, MD
Director
National Spinal Cord Injury
Data Research Center

PARCOURSE *NOT* PARACOURSE

In the Fall/1980 *SCI Digest*, the word, "PARCOURSE" was misspelled, "PARACOURSE" in the Wheelchair Endurance Program article.

Affiliated SCI Systems

UAB — Regional SCI System
Univ. of Alabama in Birmingham
Birmingham, Alabama

Southwest Regional System for
Treatment of Spinal Injury
Good Samaritan Hospital —
St. Joseph's Hospital
Phoenix, Arizona

Northern California Regional SI System
Santa Clara Valley Medical Center
San Jose, California

Regional SCI Care System
of Southern California
Rancho Los Amigos Hospital
Downey, California

Rocky Mountain Regional SCI System
Craig Hospital
Englewood, Colorado

So. Florida Regional SCI System
University of Miami
School of Medicine
Miami, Florida

Midwest Regional SCI Care System
Northwestern Memorial Hospital
Rehabilitation Institute of Chicago
Northwestern University
McGaw Medical Center
Chicago, Illinois

New England Regional SCI System
of University Hospital, 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

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