

THE COSTS OF SPINAL CORD INJURY¹

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Abstract. An ongoing study of medical care and associated costs relative to spinal cord injury is being conducted at the University of Alabama in Birmingham, one of 11 federally funded Model Regional Spinal Cord Injury Centres. It was hypothesised such costs would be lower among patients admitted into an organised continuum of care (system) soon after injury than among patients whose entry into the organised system of care was delayed (non-system).

A comprehensive economic data set has been acquired on 142 of 233 (61 per cent) patients admitted since implementation of the project.

Analysis of these data reveals: (1) system patients require, on average, expenditures of almost \$5,000 less than their non-system counterparts; (2) there is little difference in medical or associated costs and length of hospitalisation between tetraplegics and paraplegics; (3) spinal cord injuries secondary to motor vehicle accidents have higher associated costs and longer lengths of stay than do those injuries resulting from other causes including acts of violence.

Key words: System treatment; economic data; non-system treatment.

Introduction

SINCE World War II technological advances in the treatment and management of spinal cord injury have dramatically improved the long-term prognosis for these patients. To facilitate and assure the complex coordination of numerous medical specialists, various allied health disciplines, and multiple services required for optimum rehabilitation of the spinal cord injured patient 11 regional spinal cord injury centres, throughout the United States, have been designated and funded by the Department of Health, Education, and Welfare.

An important objective of each regional centre is to improve the efficiency of services and simultaneously reduce the costs. Early cost data collected and analysed at the University of Alabama in Birmingham, have been reported previously (Charles, 1974); similar data reflecting the early experience of the Midwest Regional Spinal Cord Injury Care System in Chicago has also been reported (Hamilton, 1976).

When the Model Regional Spinal Cord Injury Centre (MRSCIC) was established at the University of Alabama in Birmingham in 1972 a multidisciplinary approach was incorporated to provide medical care and rehabilitation services. The multidisciplinary approach to care was to serve as the focal point for an eventual evaluation and assessment of an organised or systematic treatment mode for spinal cord injury patients. The research design included provisions for

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establishment of an economic data base which would reflect both direct and indirect costs resulting from spinal cord trauma.

Direct costs are those associated with treatment and care of the injury; indirect costs reflect fiscal losses which result from the loss of output, productivity or opportunity secondary to morbidity and mortality (Rice, 1976).

At present, the subset of patients among the total spinal cord injury population treated at this centre, upon whom comprehensive cost data has been acquired and analysed, has reached 142 individuals. These data include costs accrued from time of injury through the first definitive discharge from a rehabilitation centre.

Methodology

The following format is utilised to acquire direct costs: When patients are admitted to the MRSCIC of the University of Alabama in Birmingham they are classified as 'system', and 'non-system'.

System patient. An Alabama resident, injured within the state, hospitalised exclusively in preselected facilities and referred to the MRSCIC within 30 days of injury.

Non-system patient. An Alabama resident, injured within the state, hospitalised for more than 24 hours in a non-selected facility or hospitalised in a preselected facility but referred to the MRSCIC more than 30 days after injury.

A MRSCIC staff member meets with the patient and/or members of the immediate family, explains the nature of the economic investigation and requests the patient's participation. If consent is obtained, an appropriate release form granting access to financial data is acquired. As of 31 December 1976, only 3 per cent of all patients admitted have withheld consent.

A personal letter is forwarded to each pre-University of Alabama in Birmingham provider (hospitals, physicians, ambulance firms, etc.) requesting a copy of all billed charges. Accompanying this letter is a copy of an endorsement of the study by the Alabama Hospital Association and a copy of the patient's financial release form as well as patient identification information which facilitates acquisition of patient records. Response to these requests provides the investigative team with detailed fiscal information for the period prior to the patient's admission to the University of Alabama in Birmingham. For the period during which the patient is hospitalised at the MRSCIC or at other hospitals or clinics affiliated with the University of Alabama in Birmingham, financial data reflecting hospital charges is obtained from the University billing information system. These data include all charges except professional fees which are obtained from a separately maintained physician billing system. Expenditures for items such as necessary medical equipment and/or environmental modification are also merged into the patient specific data base. To verify the accuracy and completeness of data collected, a cross-reference is made through the records of the various third party payers. Estimates based upon usual and customary professional charges are occasionally required, however, this has been the rare exception rather than the rule.¹

Following discharge from the MRSCIC the patient or responsible party is shown how to maintain a monthly record of all medical and related expenditures incurred as a result of the spinal cord injury. This information is merged with the patient's economic records during regularly scheduled follow-up visits as well as during frequent mail and phone communication.

¹ It should be noted also that data presented reflect billed charges and not the actual cost of the services rendered nor the amount of payment actually received.

Provision has also been made for the estimation and projection of indirect costs secondary to spinal cord injury. Data are acquired during rehabilitation and annually thereafter from the patient and/or family about employment history, income history and educational levels. These data are based on recollection and are believed to be somewhat less precise than the direct cost data, which is documented.

Presentation of Data

Current economic data reflect charges¹ for treatment and length of stay for patients in our series from the onset of injury until time of first definitive discharge from the University of Alabama in Birmingham Hospitals.

Although post-discharge data is being collected, the size of the data base is too small for meaningful analysis at this time and will not, therefore, be discussed.

The following data are being collected for all 'system' and 'non-system' patients:

1. Cost of emergency evacuation from the site of injury to all hospitals;
2. Cost of all acute care prior to transfer to the MRSCIC including all hospital charges, professional fees, and other miscellaneous expenses incurred as a result of the spinal cord injury.
3. Cost of hospitalisation and rehabilitation at the Spain Rehabilitation Center including professional fees, equipment costs, home modification costs, and other miscellaneous expenses incurred as a result of the spinal cord injury or its sequelae.

Findings: Treatment Category

When examining the cost-effectiveness of a systematic approach to the care of spinal cord injury, the first comparison should mention differences, if any, between 'system' and 'non-system' patients.

In Table I the mean costs (and standard deviations of acute care, rehabilitation, and totals for both 'system' and 'non-system' are shown. For 85 'system' patients the acute care costs averaged \$5607 (\pm \$6070), rehabilitation costs \$11,785 (\pm \$7409), and total costs \$17,394 (\pm \$11,057). For the 57 'non-system' patients the acute care cost averaged \$11,109 (\pm \$5314), rehabilitation costs \$11,383 (\pm \$6485), and total costs \$22,347 (\pm \$9165). The \$5502 difference in acute care costs and the \$4953 difference in total costs are both significant at the 0.01 level.

TABLE I

Mean cost—system *v.* non-system ($n = 142$)

Treatment category	Acute care	Rehabilitation	Total
System ($n = 85$)	\$5,607 (\pm 6,070)	\$11,785 (\pm 7,409)	\$17,394 (\pm 11,057)
Non-system ($n = 57$)	\$11,109 (\pm 5,314)	\$11,383 (\pm 6,485)	\$22,347 (\pm 9,165)
Total ($n = 142$)	\$7,780 (\pm 6,516)	\$11,624 (\pm 7,032)	\$19,382 (\pm 10,589)

¹ All dollar figures presented in this document are adjusted by the Consumer Price Index to a base of 1976 = 100. (Monthly Labor Review, 1977, 1976, 1975, 1974, 1973)

TABLE II
Mean days (length of stay) *v.* treatment category ($n = 142$)

Treatment category	Acute care	Rehabilitation	Total
System ($n = 85$)	21 (± 12)	73 (± 41)	94 (± 46)
Non-system ($n = 57$)	53 (± 21)	75 (± 43)	128 (± 46)
Total ($n = 142$)	34 (± 23)	74 (± 42)	108 (± 49)

There is no demonstrable difference in rehabilitation costs. It is interesting to note, however, that 'non-system' costs did not seem to vary as greatly as 'system' costs in any of the three categories.

Table II reflects the mean lengths of stay, in days, for both 'system' and 'non-system' patients. 'system' patients averaged 21 (± 12) days in acute care facilities, 73 (± 41) days in the rehabilitation centre, and a total of 94 (± 46) days hospitalised between trauma and definitive discharge. 'Non-system' patients spent 53 (± 21) days in acute care facilities, 75 (± 43) days in the rehabilitation centre, and a total of 128 (± 46) days hospitalised between trauma and first definitive discharge. Both the 32-day difference in acute care days and the 34-day difference in total days are significant at the 0.01 level. There is no significant difference in the days spent in the rehabilitation centre. The difference in acute care days is to be expected since the designation 'system' patient depends in part on the length of time between trauma and referral to the rehabilitation centre. The data indicate that 'system' patients have shorter lengths of stay and lower costs than the 'non-system' patients.

Level of Lesion

A comparison of quadriplegic and paraplegic patients might be expected to reveal marked differences both in costs and lengths of hospitalisation. Our data do not indicate nor even suggest any significant differences in costs for the two groups. Quadriplegic patients appear to remain hospitalised in the rehabilitation centre a few days longer than paraplegic patients, but the data is merely suggestive, not significant.

Table III shows the costs for both quadriplegic and paraplegic patients. For 66 quadriplegics, acute care costs averaged \$7705 (\pm \$6592), rehabilitation costs \$12,228 (\pm \$7804), and total costs \$19,887 (\pm \$12,067). For 76 paraplegics, acute care costs averaged \$7844 (\pm \$6493), rehabilitation costs \$11,099 (\pm \$6290), and total costs \$18,944 (\pm \$9176).

TABLE III
Mean cost—level of lesion ($n = 142$)

Level of lesion	Acute care	Rehabilitation	Total
Quads ($n = 66$)	\$7,705 ($\pm 6,592$)	\$12,228 ($\pm 7,804$)	\$19,887 ($\pm 12,067$)
Paras ($n = 76$)	\$7,844 ($\pm 6,493$)	\$11,099 ($\pm 6,290$)	\$18,944 ($\pm 9,176$)
Total ($n = 142$)	\$7,780 ($\pm 6,516$)	\$11,624 ($\pm 7,032$)	\$19,382 ($\pm 10,589$)

TABLE IV
Mean days (length of stay *v.* level of lesion ($n = 142$))

Level of lesion	Acute care	Rehabilitation	Total
Quads ($n = 66$)	33 (± 23)	79 (± 48)	112 (± 60)
Paras ($n = 76$)	34 (± 22)	70 (± 35)	104 (± 36)
Total ($n = 142$)	34 (± 23)	74 (± 42)	108 (± 49)

In Table IV we observe the average length of hospitalisations for both quadriplegic and paraplegic patients. Quadriplegic patients demonstrate a mean length of stay, in acute care facilities, of 33 (± 23) days, in the rehabilitation centre of 79 (± 48) days, and a total of 112 (± 60) days. Paraplegic patients show a mean length of stay in acute care facilities of 34 (± 22) days, in the rehabilitation centre of 70 (± 35) days, and a total of 104 (± 36) days.

Treatment Category by Level of Lesion

Inspection of Table V reveals both the length of hospitalisations and documented costs for four mutually exclusive subgroups: 'system' quadriplegics ($n = 41$), 'non-system' quadriplegics ($n = 25$), 'system' paraplegics ($n = 44$), and non-system' paraplegics ($n = 32$).

Within the group of 'system' patients, paraplegics demonstrate a slightly longer length of stay (100 ± 39) with costs being slightly higher ($\$18,495 \pm 10,959$) than those observed among 'system' quadriplegics (length of stay 88 ± 52 and costs of $\$16,212 \pm \$11,196$). Within the group of 'non-system' patients quadriplegics have longer lengths of stay ('non-system' quadriplegics 152 ± 50 , 'non-system' paraplegics $109 \text{ days} \pm 33$) and higher documented costs ('non-system' quadriplegics $\$25,914 \pm \$11,194$, 'non-system' paraplegics $\$19,560 \pm \$6,038$).

Comparing the 'system' and 'non-system' quadriplegics, it may be seen that 'system' quadriplegics have shorter lengths of stay (88 ± 52) and considerably lower costs ($\$16,212 \pm \$11,196$) when compared to 'non-system' quadriplegics (152 ± 50 and $\$25,914 \pm 11,194$). This difference is significant at the 0.01 level in each category.

TABLE V
Categories of treatment and levels of lesions by days and cost ($n = 142$)

Treatment category and level of lesion	Acute care days	Rehab. days	Total days	Acute care cost	Rehab. cost	Total cost
System/Quad ($n = 41$)	20 (± 12)	68 (± 46)	88 (± 52)	$\$5,140$ ($\pm 5,115$)	$\$11,069$ ($\pm 7,802$)	$\$16,212$ ($\pm 11,176$)
Non-system/Quad ($n = 25$)	55 (± 21)	96 (± 47)	152 (± 50)	$\$11,911$ ($\pm 6,664$)	$\$14,129$ ($\pm 7,574$)	$\$25,914$ ($\pm 11,194$)
System/Para ($n = 44$)	22 (± 12)	78 (± 36)	100 (± 39)	$\$6,042$ ($\pm 6,874$)	$\$12,453$ ($\pm 7,047$)	$\$18,495$ ($\pm 10,959$)
Non-system/Para ($n = 32$)	51 (± 22)	58 (± 31)	109 (± 33)	$\$10,322$ ($\pm 5,052$)	$\$9,238$ ($\pm 4,546$)	$\$19,560$ ($\pm 6,038$)

The situation with respect to 'system' and 'non-system' paraplegics is quite different. There is no demonstrable difference in overall days ('system' paraplegics spent more time and money in the rehabilitation centre whereas 'non-system' paraplegics spent more time and money in the acute care facilities.

Sex

Tables VI and VII distinguish between female and male patients. The 110 male patients averaged \$7742 (\pm \$6704) for acute care facilities, \$12,248 (\pm \$7072) for rehabilitation services, and a total of \$19,962 (\pm 10,921). The 32 female patients averaged \$7908 (\pm \$5924) for acute care facilities, \$9480 (\pm \$6551) for rehabilitation services, and a total of \$17,389 (\pm \$9242). The male patients averaged 33 (\pm 22) days in acute care facilities, 76 (\pm 41) days in the rehabilitation centre, and a total of 110 (\pm 49) days. The female patients averaged 35 (\pm 26) days in acute care facilities, 65 (\pm 44) days in the rehabilitation centre, and a total of 100 (\pm 49) days. These data suggest strongly that, despite the absence of statistically significant differences in acute care costs or lengths of stay, male patients take longer and cost more to rehabilitate. The difference in length of rehabilitation stay is significant at the 0.10 level, and the difference in the rehabilitation costs is significant at the 0.10 level.

TABLE VI
Mean cost—sex ($n = 142$)

Sex	Acute care	Rehabilitation	Total
Male ($n = 110$)	\$7,742 (\pm 6,704)	\$12,248 (\pm 7,072)	\$19,962 (\pm 10,921)
Female ($n = 32$)	\$7,908 (\pm 5,924)	\$9,480 (\pm 6,551)	\$17,389 (\pm 9,242)
Total ($n = 142$)	\$7,780 (\pm 6,516)	\$11,624 (\pm 7,032)	\$19,382 (\pm 10,589)

TABLE VII
Mean days (length of stay)—sex ($n = 142$)

Sex	Acute care	Rehabilitation	Total
Male ($n = 110$)	33 (\pm 22)	76 (\pm 41)	110 (\pm 49)
Female ($n = 32$)	35 (\pm 26)	65 (\pm 44)	100 (\pm 49)
Total ($n = 142$)	34 (\pm 23)	74 (\pm 42)	108 (\pm 49)

TABLE VIII
Mean cost—racial group ($n = 142$)

Racial group	Acute care	Rehabilitation	Total
White ($n = 93$)	\$8,328 (\pm 6,919)	\$11,208 (\pm 6,644)	\$19,501 (\pm 10,716)
Non-white ($n = 49$)	\$6,740 (\pm 5,594)	\$12,414 (\pm 7,725)	\$19,155 (\pm 10,452)
Total ($n = 142$)	\$7,780 (\pm 6,516)	\$11,624 (\pm 7,032)	\$19,382 (\pm 10,589)

Race

Tables VIII and IX show the differences in costs and length of stay for white and non-white patients. There is no demonstrable difference in rehabilitation costs or total costs for these two groups, but costs for whites are higher at acute

TABLE IX
Mean days (length of stay)—racial group ($n = 142$)

Racial group	Acute care	Rehabilitation	Total
White ($n = 93$)	35 (± 22)	71 (± 39)	106 (± 47)
Non-white ($n = 49$)	32 (± 23)	79 (± 46)	111 (± 53)
Total ($n = 142$)	34 (± 23)	74 (± 42)	108 (± 49)

TABLE X
Mean days and costs *v.* age

Age	Acute care days	Rehab. days	Total days	Acute care cost	Rehab. cost	Total cost
0-14 ($n = 5$)	32 (± 16)	46 (± 35)	78 (± 48)	\$7,882 ($\pm 3,414$)	\$7,369 ($\pm 4,905$)	\$15,251 ($\pm 7,377$)
15-29 ($n = 77$)	37 (± 26)	75 (± 40)	112 (± 48)	\$7,930 ($\pm 6,226$)	\$11,681 ($\pm 6,707$)	\$19,570 ($\pm 9,410$)
30-44 ($n = 27$)	33 (± 15)	78 (± 45)	110 (± 47)	\$7,360 ($\pm 3,658$)	\$12,099 ($\pm 7,510$)	\$19,459 ($\pm 9,176$)
45-59 ($n = 23$)	29 (± 18)	79 (± 46)	109 (± 56)	\$8,896 ($\pm 10,316$)	\$13,037 ($\pm 8,175$)	\$21,933 ($\pm 16,212$)
60+ ($n = 10$)	23 (± 20)	56 (± 38)	79 (± 33)	\$5,132 ($\pm 4,724$)	\$8,782 ($\pm 5,738$)	\$13,924 ($\pm 6,292$)
Total ($n = 142$)	34 (± 23)	74 (± 42)	108 (± 49)	\$7,780 ($\pm 6,516$)	\$11,624 ($\pm 7,032$)	\$19,382 ($\pm 10,589$)

care facilities ($P < 0.10$). Table IX suggests that non-whites spend less time at acute care facilities, more time at the rehabilitation centre, and more total days hospitalised than do their white counterparts.

Age

Table X presents cost and length of stay by age. Young (0-14) and older patients (60+) demonstrate lower costs and shorter lengths of stay when compared to patients in age groups between 15 and 60 years.

Aetiology

Table XI presents cost and length of stay data by aetiology. Of 142 patients in this economic sub-study, motor vehicle accidents (including pedestrian injuries) were the leading cause of trauma ($n = 64$). These patients were also the ones determined to have longest lengths of stay and highest associated costs. Spinal cord injuries secondary to acts of violence—gunshot and stabbing wounds—were

TABLE XI
Mean days and costs *v.* aetiology

Cause	Acute care days	Rehab. days	Total days	Acute care cost	Rehab. cost	Total cost
MV Driver (n = 31)	35 (± 21)	72 (± 43)	107 (± 47)	\$8,044 (± 5,807)	\$11,770 (± 7,150)	\$19,712 (± 9,016)
MV Passenger (n = 15)	41 (± 24)	98 (± 49)	138 (± 63)	\$10,091 (± 7,798)	\$12,562 (± 8,138)	\$22,653 (± 14,215)
MC Driver (n = 14)	37 (± 31)	64 (± 46)	101 (± 54)	\$7,901 (± 6,282)	\$12,544 (± 10,474)	\$20,445 (± 11,319)
MC Passenger (n = 1)	57	68	125	\$10,468	\$12,366	\$22,833
Pedestrian (n = 3)	30 (± 24)	93 (± 74)	122 (± 87)	\$9,956 (± 10,781)	\$13,135 (± 10,106)	\$23,091 (± 19,255)
Water Sports (n = 8)	38 (± 21)	91 (± 33)	129 (± 48)	\$8,631 (± 4,775)	\$12,147 (± 3,975)	\$20,779 (± 6,753)
Gunshot (n = 33)	34 (± 26)	65 (± 33)	99 (± 40)	\$8,026 (± 8,055)	\$10,735 (± 5,681)	\$18,761 (± 10,985)
Stabbing (n = 1)	34	21	55	\$4,573	\$2,568	\$7,140
Other (n = 36)	28 (± 18)	73 (± 39)	101 (± 44)	\$5,960 (± 5,066)	\$11,553 (± 6,747)	\$17,516 (± 9,884)
Total (n = 142)	34 (± 23)	74 (± 42)	108 (± 49)	\$7,780 (± 6,516)	\$11,624 (± 7,032)	\$19,382 (± 10,589)

the least expensive in terms of dollar expenditures and periods of hospitalisation. It is believed that multiple associated injuries account, at least in part, for the disparity in costs associated with the divergent aetiologies.

RÉSUMÉ

A l'Université d'Alabama à Birmingham, qui est un des onze Centres Régionaux consolidés fédéralement comme modèles pour le traitement des traumatisés de la moelle épinière, on doncuit une étude courante des frais d'hospitalization. On a hypothésé que tels frais seraient moins élevés chez les malades qui ont reçus leur soin aussitôt que possible après leur traumatisme dans un hôpital organisé systématiquement comme le nôtre.

L'information économique compréhensive a été étudiée pour 129 des 359 (36 pour cent) des malades admis dès le début du projet.

L'analyse de ces données montre: (1) les malades qui sont sous le système exigent, en moyenne, un soin médical qui coûte presque \$5,000.00 moins que ceux qui ne le sont pas; (2) il y a peu de différence au sujet des frais médicaux (ou para-médicaux) et de la durée d'hospitalization entre les tétraplégiques et les paraplégiques; (3) les traumatisés de la moelle duent à des accidents de la route coûtent plus cher at exigent plus de temps d'hospitalization que ceux duent à d'autres causes, même des actes de violence.

ZUSAMMENFASSUNG

Eine Studie über medizinisch-therapeutische und begleitende Kosten nach Rückenmarksverletzungen wird zur Zeit an der Universitaet von Alabama in Birmingham, einer von elf durch die amerikanische Bundesregierung finanzierten regionalen Modellzentren zur Behandlung von Rückenmarksverletzten, durchgeführt. Hypothetisch müssten die Kosten bei Patienten niedriger sein, die sofort nach dem Ereignis in eine systematische Behandlung (Systembehandlung) kommen, verglichen zu den Kosten, die anfallen, wenn die Patienten erst später in eine Systembehandlung überwiesen werden.

Eine zusammenfassende Übersicht über die wirtschaftlichen Gesichtspunkte wurde an Hand der Daten von 142 (61%) der 233 Patienten, die in das Birminghamer Programm seit Bestehen des Projektes aufgenommen wurden, ermittelt.

Die Analyse dieser Daten zeigt folgendes Ergebnis:

(1) Die Ausgaben für Patienten, die von Beginn an in Systembehandlung waren, belaufen sich im Durchschnitt auf etwa 5,000 \$ weniger, als diejenigen fuer Patienten, die primär nicht System behandelt wurden.

(2) Es besteht kein signifikanter Unterschied in der Höhe von medizinischen und begleitenden Kosten und der Länge der Krankenhausbehandlung zwischen Tetraplegikern und Paraplegikern.

(3) Die begleitenden Kosten von Rückenmarksverletzungen als Folge von Autounfällen sind erheblich höher, und die Patienten bedürfen einer erheblich längeren stationären Behandlungszeit als die Patienten, deren Rückenmarksverletzung andere Ursachen hat einschliesslich derjenigen nach Akten der Gewalt.

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