

## Directed rehabilitation reduces pain and depression while increasing independence and satisfaction with life for patients with paraplegia due to epidural metastatic spinal cord compression

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**Abstract**—We determined whether directed rehabilitation affected survival, pain, depression, independence, and satisfaction with life for veterans who were nonambulatory after spinal epidural metastasis (SEM) treatment. We compared 12 consecutive paraplegic veterans who received 2 weeks of directed rehabilitation with a historical control group of 30 paraplegic veterans who did not receive rehabilitation. The rehabilitation program emphasized transfers, bowel and bladder care, incentive spirometry, nutrition, and skin care. The outcome measures were survival, independence, pain levels, depression, and satisfaction with life. Patients receiving rehabilitation had longer median survivals, fewer deaths from myelopathic complications, less pain 2 weeks after SEM treatment, lower depression scores, and higher satisfaction with life scores. In addition, among the patients who received rehabilitation, eight became independent for transfers (vs zero controls) and nine returned home (vs six controls). We conclude that directed rehabilitation reduced patients' pain levels and increased their mobility, survival, and life satisfaction.

**Key words:** cancer rehabilitation, depression, metastatic cancer, myelopathy, pain, paraplegia, satisfaction with life, spinal cord compression, spinal epidural metastasis, survival.

### INTRODUCTION

A spinal epidural metastasis (SEM) compressing the spinal cord is the most common way that systemic cancer causes spinal cord dysfunction [1–2]. Many types of cancer

metastasize to the spinal column, and 5 to 10 percent of people with cancer develop a symptomatic SEM [1–4]. SEMs are present in the autopsies of one-third of patients with cancer [5]. The annual incidence of SEM in the United States increased from ~18,000 in 1987 to ~25,000 in 1996 [2].

Among patients with spinal cord injury (SCI) (excluding patients with demyelinating diseases), 61 percent have traumatic SCI and 10 percent have SCI as a result of cancer [6]. During the first year after injury, the leading causes of death for people with traumatic SCI are respiratory diseases including pneumonia and infections originating in the urinary system or from pressure sores [7]. The mortality rate for nonambulatory patients with acute traumatic SCI is about 12 percent during the first 4 months

**Abbreviations:** ASIA = American Spinal Injury Association, BDI-II = Beck Depression Inventory-Second Edition, CI = confidence interval, LSCVAMC = Louis Stokes Cleveland Department of Veterans Affairs Medical Center, NSAID = nonsteroidal anti-inflammatory drugs, Rehab = rehabilitation, RT = radiation therapy, SCI = spinal cord injury, SEM = spinal epidural metastasis, SWLS = Satisfaction with Life Scale.

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after injury [8]. One study found that the median survival of patients with SEM was 104 weeks for ambulatory patients and 6 weeks for nonambulatory patients [9]. In that study, 14 of the 30 nonambulatory patients (47%) died of myelopathic complications, such as pneumonia, infected pressure sores, and urosepsis, which are the leading causes of death in the first year after traumatic SCI.

Several factors may contribute to the higher mortality rate of nonambulatory SEM patients compared with patients with traumatic SCI. Patients can die from direct complications of systemic cancer. In addition, the likelihood of adverse myelopathic complications increases in patients with SEM. In previous studies, the mean age of patients with SEM was about 40 years older than that of patients with traumatic SCI [8–9]. Furthermore, the coexistence of systemic cancer resulting in a catabolic state may increase the likelihood of complications of immobility and death [1]. Patient age and the presence of cancer are two factors that are not alterable. However, a third factor that is alterable is rehabilitation. Specialized rehabilitation is usually provided to patients with traumatic SCI but not to patients who develop SCI due to systemic cancer [6].

We performed a prospective evaluation of 12 consecutive male veterans who developed SEM and were unable to walk after completion of SEM treatment. Spinal cord medicine rehabilitation programs for people with traumatic SCI improve independence, self-perceived quality of life, and survival [7,10–11]. We developed a 2-week rehabilitation program that emphasized training in transfers, skin care, nutrition, and pulmonary exercise with incentive spirometry. Here, we report the outcomes of these 12 patients compared with a historical control group of the 30 nonambulatory patients from the aforementioned study of SEM [9]. The historical control group did not receive directed spinal cord rehabilitation. We examined patient survival, pain control, depression, mobility independence, frequency of returning home, and self-reported satisfaction with life. To our knowledge, this is the first study to evaluate spinal cord rehabilitation for people with paraplegia due to SEM.

## METHODS

From July 2001 to September 2004, we prospectively evaluated 12 consecutive patients (Rehabilitation group, hereafter called the Rehab group) who presented to the Louis Stokes Cleveland Department of Veterans Affairs

Medical Center (LSCVAMC) with SEM and were unable to walk after completion of SEM treatment. Details of the SEM treatment with glucocorticoid medication (dexamethasone) and radiation therapy (RT) have been previously described [9]. The RT protocol and dexamethasone dose were the same for all subjects reported here. The SEM treatment protocol was similar to the protocols used in several prior studies of SEM [4,9,12–14]. Patients were considered ambulatory if they could walk without human assistance at least 50 feet without stopping. The 12 nonambulatory patients were offered the opportunity to engage in a 2-week rehabilitation program to help them adapt to their paraplegia. All patients accepted. This study was approved and continuously reviewed by the Quality Assurance Committee of the Neurology Department of Case Western Reserve University, the LSCVAMC Quality Assurance Service, the LSCVAMC Clinical Executive Committee, and the LSCVAMC Institutional Review Board.

### Rehabilitation Training

The 2-week inpatient rehabilitation program emphasized patient and caregiver training on transfers, bowel and bladder care, incentive spirometry, nutrition, and skin care. Training was provided 6 days a week; each treatment day, patients received 2 hours of occupational therapy and 2 hours of training by a nurse that focused on transfers, wheelchair use, personal hygiene, incentive spirometry, skin care, and bowel and bladder management. In addition, patients received 30 minutes of physical therapy 6 days a week to maintain range of motion of paralyzed joints. This rehabilitation program included the essential elements of rehabilitation used for patients with paraplegia due to traumatic SCI [11]. Patients entered the rehabilitation program within 1 day of completing RT.

#### *Incentive Spirometry*

Each patient's nurse provided a 20-minute training in the use of incentive spirometry. The nurses encouraged the patients to increase their expiratory volumes and trained the caregivers to reinforce and, when needed, help patients perform incentive spirometry four times a day.

#### *Transfer and Unweighting Training*

Typically, most of the 2 hours of daily occupation therapy was devoted to transfer training and unweighting techniques. When a patient was unable to independently transfer from bed to chair and chair to commode, we trained the caregiver to use a lift to transfer the patient.

### *Skin Care and Bladder and Bowel Management*

Occupational therapists trained patients to use mirrors to facilitate skin inspection. Patients and caregivers also received about 2 hours of daily nursing instruction on skin care and bowel and bladder management. Nurses reinforced skin care and the transfer techniques learned in occupational therapy. Nurses taught patients and caregivers intermittent bladder catheterization techniques. Bowel care consisted of combined medication and mechanical techniques that facilitated bowel evacuation three times a week. Patients typically received 100 mg of docusate sodium three times a day to soften their stool. The dose of stool softener was adjusted for adequate stool softening. The patient, caregiver, or both were trained to administer a minienema containing 283 mg of docusate sodium along with digital stimulation to facilitate bowel evacuation. The 10 patients who could sit unassisted learned to complete bowel care on a raised commode seat that could be located above a conventional toilet. Nurses taught the caregivers of the other two patients to complete bowel care in bed. The in-bed bowel care training included instruction on the use of pads for preventing soiling of bedding.

### *Dietary Counseling*

Each patient and caregiver in the Rehab group received two instructional sessions with a dietician to learn dietary manipulations to combat catabolism and to develop a diet that supported the patient's bowel management program.

### **Historical Control Group**

The Rehab group was compared with a historical control group (hereafter called the No Rehab group) from a recently completed study of SEM treatment conducted at the LSCVAMC [9]. The No Rehab group included 30 veterans who were unable to walk after SEM treatment. The subjects in the No Rehab group did not receive spinal cord rehabilitation but did receive physical therapy 3 hours a week for at least 2 weeks. The physical therapy focused on range of limb motion and strengthening of residual lower-limb motor function. Measures of pain after completion of SEM treatment, depression severity, and satisfaction with life for the No Rehab group were previously collected but presented only in abstract form [15–17]. Demographics of the study and control groups are shown in **Table 1**.

**Table 1.**

Demographic comparison of study group that received 2 weeks of rehabilitation (Rehab,  $n = 12$ ) and control group that did not (No Rehab,  $n = 30$ ).

Characteristic	Rehab	No Rehab
Age (mean $\pm$ standard error of the mean)	67.8 $\pm$ 2.9	69.1 $\pm$ 1.6
Education, $n$ (%)		
High School	6 (50)	13 (43)
Some College	3 (25)	9 (30)
College Degree	3 (25)	8 (27)
Tumor Type, $n$ (%)		
Prostate	5 (42)	13 (43)
Lung	5 (42)	12 (40)
Other	2 (17)	5 (17)
Spinal Level, $n$ (%)		
Above T6	5 (42)	10 (33)
T6 to T12	4 (33)	11 (37)
Below T12	3 (25)	9 (30)
ASIA Grade, $n$ (%)		
A	6 (50)	11 (37)
B	6 (50)	12 (40)
C	0 (0)	6 (20)
D	0 (0)	1 (3)*

\*Patient classified with American Spinal Injury Association (ASIA) grade D at onset of spinal epidural metastasis treatment and deteriorated to grade B. T = thoracic.

Patients in both groups had had detailed neurological physical examinations before starting SEM treatment; the examinations included classification of the severity and level of the myelopathy according to the American Spinal Injury Association (ASIA) classification system [18]. Briefly, this classification system includes the following grades: A = complete myelopathy, B = sensory sparing without motor function, C = partial motor sparing with most tested muscles graded at  $<3/5$  (not antigravity) on manual muscle testing, D = more complete motor sparing with most tested muscle graded at  $>3/5$ , and E = no motor or sensory deficit. Patients in both groups were followed until their deaths. After discharge from inpatient care, patients were followed by telephone contacts every month and outpatient visits every 3 months.

### **Subject Inclusion and Exclusion Criteria**

Our patient selection criteria were designed to include patients who had had similar SEM treatments. The inclusion criteria were (1) an SEM that was producing myelopathy and (2) an inability to walk after SEM treatment. The exclusion criteria were (1) refusal of SEM treatment,

(2) cauda equina syndrome without myelopathy, (3) prior SEM that had produced myelopathy, and (4) surgical treatment of SEM. We excluded five patients who had developed paraplegia due to SEM (four who would have entered the No Rehab group and one who could have entered the Rehab group) because they refused SEM treatment. We excluded another four patients from the No Rehab group because they had had surgical spinal canal decompression because of the presence of bone fragments in the spinal canal. Excluding patients with bone fragments may have improved the survival of the No Rehab group because patients with bone fragments have very poor prognoses [19–20]. The patients who were excluded from this study had poor prognoses. Eight of the nine excluded patients would have entered the No Rehab group. Consequently, if the excluded patients had been included in the study, the No Rehab group would likely have had poorer outcomes.

### Outcome Measures

The main outcome measure was patient survival. The secondary outcome measures were level of pain, ability to transfer, self-reported severity of symptoms of depression, self-reported satisfaction with life, frequency of achieving mobility independence, and frequency of returning home. Note that patients entered the Rehab group within 1 day of completing SEM treatment; therefore, measurements made 2 weeks after completion of SEM treatment in the No Rehab group were temporally comparable with measurements made at the completion of SEM treatment in the Rehab group.

#### *Depression and Satisfaction with Life*

Depression and satisfaction with life were assessed after completion of SEM treatment and completion of rehabilitation for the Rehab group or 2 weeks after completion of SEM treatment for the No Rehab group. Depression was assessed with the Beck Depression Inventory-Second Edition (BDI-II) [21]. The BDI-II is a 21-item self-report instrument that has been extensively validated. The BDI-II can be administered in less than 10 minutes. Each BDI-II item is scored on a four-point scale ranging from 0 to 3. A total BDI-II score of 0 to 13 indicates minimal depression, 14 to 19 mild depression, 20 to 28 moderate depression, and 29 to 63 severe depression. Higher total scores indicate more severe depressive symptoms. The BDI-II is positively correlated with the Hamilton Depression Rating Scale (Pearson  $r = 0.71$ ). The test also has high 1-week test-retest reliability

(Pearson's  $r = 0.93$ ) [22] and high internal consistency ( $\alpha = 0.91$ ) [23]. The BDI-II is routinely used for assessing self-reported symptoms of depression in persons with SCI [24–26] and persons with cancer that involves the central nervous system [27].

Self-perceived satisfaction with life was assessed with the Satisfaction with Life Scale (SWLS) [28–29]. The SWLS consists of five statements to which subjects respond using a seven-point scale, with 1 denoting strong disagreement and 7 strong agreement. A total SWLS score of 5 to 9 indicates extreme dissatisfaction, 10 to 14 dissatisfaction, 15 to 19 slight dissatisfaction, 20 neutral, 21 to 25 slight satisfaction, 26 to 30 satisfaction, and 31 to 35 extreme satisfaction. Coefficient  $\alpha$  for the SWLS has been reported to be 0.87, while test-retest reliability after a 2-month interval has been reported to be 0.82 [28]. The SWLS is valid and reliable for a variety of ages and applications. It demonstrates a high level of convergence on self- and peer-reported measures of subjective well-being and life satisfaction [30]. The SWLS is routinely used for evaluating self-reported satisfaction with life in persons with SCI [31–34]. The two groups' BDI-II and SWLS values are provided in **Table 2**.

#### *Pain*

We assessed pain levels before, immediately after, and 2 weeks after SEM treatment or completion of rehabilitation. The patients scored their highest pain levels experienced during the prior 24 hours on a numerical rating scale from 0 to 10, with 0 indicating no pain and 10 unbearable pain [35]. Patients with pain levels  $\leq 4$  were offered 650 mg of acetaminophen four times a day for the pain. Patients with more intense pain were offered opioid

**Table 2.**

Beck Depression Inventory-Second Edition (BDI-II) and Satisfaction with Life Scale (SWLS) scores (mean  $\pm$  standard error of the mean). Measured just after completion of spinal epidural metastasis (SEM) treatment and after either 2 weeks directed rehabilitation (Rehab group,  $n = 12$ ) or 2 weeks after SEM treatment (No Rehab group,  $n = 30$ ).

Measure	Rehab	No Rehab
BDI-II Post-SEM Treatment	30.3 $\pm$ 2.4	29.6 $\pm$ 2.4
BDI-II 2 wk Post-SEM Treatment	13.2 $\pm$ 3.5*	36.5 $\pm$ 1.9
SWLS Post-SEM Treatment	11.2 $\pm$ 0.8	10.8 $\pm$ 0.6
SWLS 2 wk Post-SEM Treatment	27.0 $\pm$ 0.7*	11.1 $\pm$ 0.7

\*Rehab had lower BDI-II and higher SWLS scores after rehabilitation than before start of rehabilitation ( $p < 0.001$ ). At completion of rehabilitation, Rehab had lower BDI-II and higher SWLS scores than No Rehab ( $p < 0.001$ ).

medications. The amounts of opioid and nonsteroidal anti-inflammatory drugs (NSAID) required for treating pain were monitored for both groups. We compared the amount of pain medications (opioid alone and opioid + NSAID) that patients consumed each day by using a standard equianalgesic pain medication conversion table [36]. Pain data are presented in **Table 3**.

### Statistical Methods

Patient survival was defined as the time between the completion of SEM treatment and death. Patient survival was assessed by the Kaplan-Meier life-table estimation method [37–38]. The confidence interval (CI) for the median survival was calculated according to standard techniques [37]. The Kaplan-Meier technique is the recognized approach for calculating survival in studies of patients with cancer and other conditions [39].

Some of the secondary outcome measures of pain, depression, satisfaction with life, mobility, and returning home data show nonnormality when the box plot, histogram, and normal probability plot (normal Q-Q plot) of the data are checked [40]. Hence, we used a nonparametric test, the two-sample Wilcoxon Rank Sum Test (also known as the Mann-Whitney test), to analyze the secondary outcome measures [41]. The Wilcoxon Test requires that all the values in each sample follow the same continuous distribution and that within each sample, the values are independent and identically distributed, which are reasonable assumptions in our study. Risk ratios (also known as relative risks) and their CIs were calculated by standard techniques [42]. **Table 4** provides statistical

parameter values from the Wilcoxon Rank Sum Test statistical analysis.

## RESULTS

### Patient Survival

The two groups had similar cancer-type and age distributions (**Table 1**). The two groups also had similar distributions of spinal levels and ASIA grades at the beginning of SEM treatment. One No Rehab patient's grade deteriorated from ASIA D to B during SEM treatment. No other patient changed ASIA grade during SEM treatment and no patient changed spinal level. All patients were incontinent of bladder and bowel and required catheter drainage of the bladder. The patients who received rehabilitation survived longer (**Figure**). Median survival for the Rehab group was 26 weeks (95% CI = 23.9–28.1 weeks) compared with 6 weeks (95% CI = 5.9–6.1 weeks) for the No Rehab group ( $p < 0.001$ ). The difference in survival between the two groups was 20 weeks (95% CI = 17.9–22.1 weeks). For comparison, in a prior study of SEM at the LSCVAMC [9], the median survival of the 109 subjects who could walk after SEM treatment was 104 weeks. None of the Rehab patients died of complications of myelopathy, whereas 47 percent of the No Rehab patients died of complications of myelopathy ( $p < 0.001$ ). For a death to be attributed to myelopathy, the patient could not have had hepatic, renal, pulmonary, or other organ system failure due to systemic cancer. The causes of death that we attributed to myelopathy included (1) pneumonia without primary or metastatic cancer that involved more than one pulmonary lobe, (2) cancer that produced airway obstruction (10 patients) and systemic sepsis that began with urosepsis (3 patients), and (3) infected decubitus ulcers (1 patient). Systemic cancer was the cause of death in 92 percent of the Rehab group and 53 percent of the No Rehab group. One patient in the Rehab group died from myocardial infarction 141 weeks after completion of SEM treatment.

### Level of Independence for Activities of Daily Life

Eight (67%) of the patients in the Rehab group learned to independently transfer from bed to wheelchair and wheelchair to commode. In contrast, none of the patients in the No Rehab group learned to be independent in transfers ( $p < 0.001$ ). At the completion of rehabilitation for the

**Table 3.**

Pain scores (mean  $\pm$  standard error of the mean) before spinal epidural metastasis (SEM) treatment, upon completion of SEM treatment, and after either 2 weeks directed rehabilitation (Rehab,  $n = 12$ ) or 2 weeks after SEM treatment (No Rehab,  $n = 30$ ). Patients rated pain on 0–10 scale, with 0 indicating no pain and 10 unbearable pain.

Time of Measure	Rehab	No Rehab
Pre-SEM Treatment	8.9 $\pm$ 0.3	8.8 $\pm$ 0.2
Post-SEM Treatment*	6.2 $\pm$ 0.3	6.4 $\pm$ 0.3
2 wk Post-SEM Treatment <sup>†</sup>	4.2 $\pm$ 0.3	6.4 $\pm$ 0.3

\*Both groups' pain levels were lower after SEM treatment compared with before SEM treatment ( $p < 0.001$ ).

<sup>†</sup>No Rehab pain levels were similar just after completion of SEM treatment and 2 weeks later. In contrast, Rehab pain levels were lower after rehabilitation compared with after completion of SEM treatment ( $p < 0.001$ ). After completion of rehabilitation, Rehab had lower pain than No Rehab ( $p < 0.001$ ).

**Table 4.**Statistical parameters for Group 1 (No Rehab,  $n = 30$ ) and Group 2 (Rehab,  $n = 12$ ).

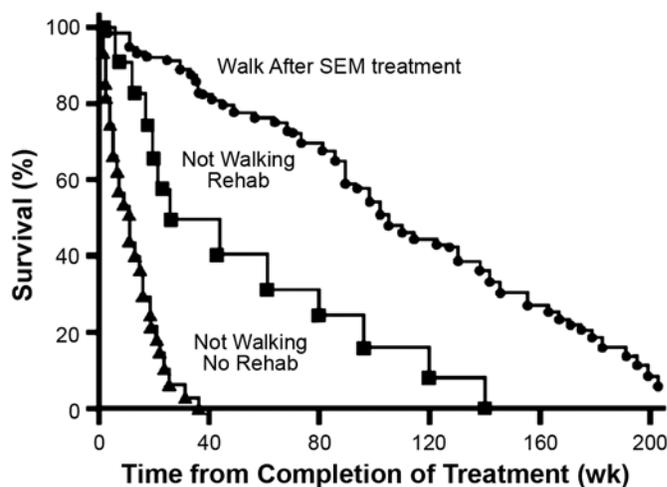
Analysis Variable	Group	Mean $\pm$ Standard Error of the Mean	Two-Sample Wilcoxon Statistic	Standardized Wilcoxon Statistic	$p$ -Value, Wilcoxon Test (Two-Sided)
Age	1	69.1 $\pm$ 8.9	239.5	-0.502	0.616
	2	67.7 $\pm$ 10.1			
BDI-III	1	29.6 $\pm$ 13.2	272.5	0.390	0.696
	2	30.3 $\pm$ 8.4			
BDI-II2	1	36.5 $\pm$ 10.8	114.0	-4.001	<0.001
	2	13.2 $\pm$ 12.0			
PL1	1	8.8 $\pm$ 1.2	265.5	0.204	0.838
	2	8.9 $\pm$ 1.2			
PL2	1	6.4 $\pm$ 1.6	238.5	-0.547	0.584
	2	6.2 $\pm$ 0.9			
PL3	1	6.4 $\pm$ 1.8	135.5	-3.467	<0.001
	2	4.2 $\pm$ 0.9			
SWLS1	1	10.8 $\pm$ 3.5	263.5	0.140	0.889
	2	11.2 $\pm$ 2.7			
SWLS2	1	11.1 $\pm$ 3.7	438.0	5.010	<0.001
	2	27.0 $\pm$ 2.5			

BDI-III = Beck Depression Inventory-Second Edition (BDI-II) post-SEM treatment and prerehabilitation, BDI-II2 = BDI-II postrehabilitation, PL1 = Pain Level (PL) pre-SEM treatment, PL2 = PL post-SEM treatment and prerehabilitation, PL3 = PL postrehabilitation, SEM = spinal epidural metastasis, SWLS1 = Satisfaction with Life Scale (SWLS) post-SEM treatment and prerehabilitation, SWLS2 = SWLS postrehabilitation.

Rehab group or 2 weeks after completion of SEM treatment for the No Rehab group, the number of subjects who were discharged to home were nine (75%) for the Rehab group and six (20%) for the No Rehab group ( $p < 0.01$ ). No patient was discharged to home after the 2-week window after completion of SEM treatment. All patients who became independent for transfers were discharged to home. The risk ratio for being discharged to home for the Rehab group compared with the No Rehab group was 3.75 with a 95% CI of 2.31 to 6.09.

### Depression

After completion of SEM treatment, the No Rehab group patients were more likely to be diagnosed with clinical depression and treated with antidepressant medication by the physicians providing their day-to-day management. The managing physicians were unaware of the values of the data being collected. By 2 weeks after completion of SEM treatment, 26 patients in the No Rehab group (86.7%) were clinically depressed and treated with antidepressant medications. Within the Rehab group, only one patient (8.3%) was diagnosed with depression. The risk ratio for being clinically diagnosed with depression among No Rehab patients compared with Rehab patients was 10.4 with a 95% CI of 5.81 to 18.6. For comparison,

**Figure.**

Rehabilitation (rehab) prolongs life of nonambulatory patients with spinal epidural metastasis (SEM). Comparison of survival after completion of SEM treatment. Curves shown for patients who could not walk after completion of SEM treatment and did not receive rehab ( $\blacktriangle$ , Not Walking No Rehab), patients who could not walk after completion of SEM treatment and received 2 wk rehab ( $\blacksquare$ , Not Walking Rehab), and patients who could walk after completion of SEM treatment ( $\bullet$ , Walk after SEM treatment). *Source* (Not Walking No Rehab and Walk After SEM treatment groups data): Zaidat OO, Ruff RL. Treatment of spinal epidural metastasis improves patient survival and functional state. *Neurology*. 2002;58(9):1360-66. [PMID: 12011281](https://pubmed.ncbi.nlm.nih.gov/12011281/)

8.26 percent of the 109 ambulatory patients from the prior SEM study were clinically depressed ( $p < 0.001$ ) [9].

The BDI-II scores showed that the severity of depression at the completion of SEM treatment was similar for the Rehab and No Rehab groups (**Table 2**). However, at 2 weeks after completion of SEM treatment, the BDI-II scores supported the clinical perception of more severe depression among the No Rehab patients. The mean BDI-II score after the 2-week rehabilitation for the Rehab group corresponded to minimal to mild depression. In contrast, the mean BDI-II score for the No Rehab group indicated severe depression.

### SWLS Scores

At the completion of SEM treatment, the two groups had similar SWLS scores (**Table 2**). The scores for both groups at the completion of SEM treatment indicated that the patients were dissatisfied with life. The SWLS scores for the No Rehab group had not improved at 2 weeks after completion of SEM treatment. In contrast, the Rehab group had higher SWLS scores after completion of rehabilitation than at the start of rehabilitation ( $p < 0.001$ ). At completion of rehabilitation, the Rehab group had higher SWLS scores compared with the No Rehab group ( $p < 0.001$ ). The Rehab group's mean SWLS score indicated satisfaction with life.

### Pain

At the onset of SEM treatment, patients rated their highest pain levels within the past 24 hours on a 0 to 10 pain scale. Both patient groups had similar, high levels of pain before SEM treatment (**Table 3**). Both patient groups reported decreased pain, to a similar degree, in association with SEM treatment. However, pain levels differed significantly between the two groups 2 weeks after completion of SEM treatment (**Table 3**). Pain levels for the No Rehab group did not change during the 2 weeks after completion of SEM treatment. In contrast, after completion of the rehabilitation program, the Rehab group had lower pain levels than before the rehabilitation program and lower pain levels than the No Rehab group.

The lower pain levels reported by patients in the Rehab group were not due to more aggressive medical treatment of pain. To compare the amount of pain medications consumed by the patients, we used standard pain medication conversion formulas to convert total daily intake of opioids and NSAID to equivalent doses of morphine sulfate. The Rehab group consumed 35 percent of

the dose of opioids and 32 percent of the dose of total pain medication (opioid + NSAID) compared with the No Rehab group.

## DISCUSSION

In this study, the outcomes of the two subject groups were significantly different for the main outcome measure and all the secondary outcome measures. The patients with paraplegia due to SEM who received a 2-week course of directed rehabilitation lived longer (**Figure**), were more likely to be independent for transfers, were more likely to return home, had lower BDI-II scores that were associated with a lower prevalence of clinical depression (**Table 2**), had lower pain scores (**Table 3**), and had higher SWLS scores that indicated that, as a group, they were satisfied with life (**Table 2**). We suggest that the reduced likelihood of clinical depression, lower BDI-II scores, and higher SWLS scores for the Rehab group resulted in part from these patients' reduced pain and greater independence.

The Rehab and No Rehab groups were not evaluated simultaneously. We are unaware of any changes in the SEM treatment between the period in which the No Rehab patients were treated and the period in which the Rehab patients were treated. However, some differences in the outcomes of groups may have resulted from unrecognized changes in patient care rather than from the rehabilitation provided to the Rehab group.

The rehabilitation program that we developed was abbreviated compared with programs provided to people with traumatic SCI because we recognized that our subjects' life expectancies were shortened by their systemic cancers. The customized 2-week protocol excluded some aspects of spinal cord rehabilitation programs designed for people with traumatic SCI. We did not include driver training, recreational therapy, pool therapy, or physical therapy directed at increasing lower-limb strength for eventual standing and walking training. In addition to shorter life expectancies, the subjects in our study were elderly and therefore we excluded therapy designed to help people stand and walk after SCI. One author's personal experience with spinal cord rehabilitation has been that, for similar severity of myelopathy, elderly people are less likely to regain standing and ambulation skills and often do not have the cardiovascular endurance required to complete physical therapy designed to help the patient return to standing and walking. An additional

factor considered was that the nonambulatory subjects in this study had severe myelopathy. Prognosis for recovery of function is associated with ASIA classification for patients with traumatic SCI [43–44]. Patients who have paraplegia with ASIA grades A or B are unlikely to recover walking. We recently analyzed the prognostic value of ASIA grades in patients with SEM [45]. We found that patients who had myelopathy with ASIA grades A, B, or C and were unable to walk at the completion of SEM treatment did not recover walking ability later. All the patients in the Rehab group were ASIA grades A or B. Hence, we felt that excluding rehabilitation aimed at recovery of ambulation was justified because of the time required for such training and the low likelihood of success.

The survival of the Rehab group was intermediate when compared with the No Rehab group and the ambulatory group of patients from the prior study of SEM conducted at the LSCVAMC (Walk After SEM treatment, **Figure**) [9]. Several prior studies of SEM suggested that patients who walk after SEM treatment live longer [9,13,19–20]. Some of the difference in survival for ambulatory versus nonambulatory patients may have resulted from differences in the aggressiveness of individual cancers [1–2].

The longer survival of the Rehab group compared with the No Rehab group (**Figure**) was due in part to the elimination of deaths from complications of myelopathy. None of the patients in the Rehab group died of complications of myelopathy, whereas 47 percent of the patients in the No Rehab group did. In addition, the shorter survival of the No Rehab group compared with the Rehab group may have been related to increased depression among the No Rehab patients. Increased depression, determined by the BDI-II, was associated with shorter survival in people with central nervous system cancer [27]. Depression can affect the survival of people with cancer in several possible ways. A person with cancer and depression may concede and surrender to the cancer, including stopping any treatments that may alter cancer progression [27]. Depression may be more than a purely psychological reaction to the cancer. Physiological changes induced by depression, including disrupted hypothalamic-pituitary function, changed cytokine activity, and altered fatty acid and phospholipid metabolism, can alter the body's responses to cancer [46–49]. Depression is associated with elevated cortisol levels, and effective treatment of depression will reduce cortisol levels and lengthen survival [50–51].

Based upon the findings of this study, the LSCVAMC Spinal Cord Injury Unit has adopted a policy of offering directed rehabilitation to patients unable to walk after SEM treatment. This policy was approved by the LSCVAMC Quality Assurance Service and the LSCVAMC Clinical Executive Committee. The Rehab group included only 12 patients. Consequently, other facilities may wish to consider data from a larger study group before adopting a similar policy. For those who wish to provide rehabilitation for cancer patients who develop SEM, we suggest the following three criteria for selecting the patients who will benefit most: (1) the patients and their support network should be accepting and willing to participate in a rehabilitation program, (2) the state of the primary malignancy should permit an estimated survival of 6 months or more, and (3) resources should be available for educating patients and their caregivers on transfers, skin care, incentive spirometry, and nutrition. Future studies on rehabilitation for nonambulatory SEM patients might consider ways to provide rehabilitation training on an outpatient basis and determine whether rehabilitation should target a subset of nonambulatory SEM patients.

## CONCLUSIONS

The findings in this study suggest that provision of a 2-week rehabilitation program increased survival. At the end of the rehabilitation program, patients had less pain and depression and improved satisfaction with life. We believe that the differences in outcomes resulted from the 2-week rehabilitation program. However, other factors possibly could have contributed to the differences in the outcomes of the two study groups. The Rehab and No Rehab patients were evaluated at different times. While we are unaware of systematic changes in patient care, unrecognized differences in the experiences of the two groups could possibly have contributed to the differences in outcomes.

A more convincing protocol for evaluating the effect of rehabilitation on people unable to walk after completing SEM treatment would be a randomized controlled multicenter clinical trial. Hopefully, the findings presented here will stimulate and justify a randomized clinical trial of rehabilitation for people who are nonambulatory due to an SEM.

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