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Telehealth: Reaching Out to Newly Injured Spinal Cord Patients

S Y N O P S I S

Objectives. The authors present preliminary results on health-related outcomes of a randomized trial of telehealth interventions designed to reduce the incidence of secondary conditions among people with mobility impairment resulting from spinal cord injury (SCI).

Methods. Patients with spinal cord injuries were recruited during their initial stay at a rehabilitation facility in Atlanta. They received a video-based intervention for nine weeks, a telephone-based intervention for nine weeks, or standard follow-up care. Participants are followed for at least one year, to monitor days of hospitalization, depressive symptoms, and health-related quality of life.

Results. Health-related quality of life was measured using the Quality of Well-Being (QWB) scale. QWB scores ($n = 111$) did not differ significantly between the three intervention groups at the end of the intervention period. At year one post discharge, however, scores for those completing one year of enrollment ($n = 47$) were significantly higher for the intervention groups compared to standard care. Mean annual hospital days were 3.00 for the video group, 5.22 for the telephone group, and 7.95 for the standard care group.

Conclusions. Preliminary evidence suggests that in-home telephone or video-based interventions do improve health-related outcomes for newly injured SCI patients. Telehealth interventions may be cost-saving if program costs are more than offset by a reduction in rehospitalization costs, but differential advantages of video-based interventions versus telephone alone warrant further examination.

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Spinal cord injuries (SCIs) are infrequent but often catastrophic occurrences. They produce permanent changes in sensory and motor function and a range of physical impairments. In mild cases, people with SCIs may be able to walk with assistive devices, while complete paralysis and even ventilator dependence result in the more severe cases. Automobile accidents are the most common cause of SCIs and annual incidence rates vary from 30 to 50 injuries per million people.^{1,2} The mean age at injury is 32 years with males comprising 82% of the SCI population.³

Because of the profound physiological impact of SCIs, those affected are at increased risk for a number of secondary health conditions. Common secondary conditions include urinary tract infections, spasticity, pressure sores, depression, and deep vein thrombosis.⁴

Preventing the onset of secondary conditions for people with a disabling condition, such as a spinal cord injury, is of substantial public health significance. Secondary conditions affect the health and well-being of disabled people as they impede the achievement of life goals and detrimentally impact quality of life. Some secondary conditions are even fatal. Seven to eight percent of deaths of those with SCIs, for example, are attributable to pressure ulcers, a common, often preventable, secondary condition.⁵ Robust data on the time of onset and rate of occurrence of secondary conditions are lacking. In order to focus attention on the issue, health promotion and the prevention of secondary conditions among those with SCI have been explicitly included in the goals of Healthy People 2010.

Rehabilitation cost pressures. While prevention of secondary conditions has been newly incorporated into public health goals, changes in the market for rehabilitative care are potentially increasing the risk of secondary conditions developing. SCIs are costly injuries: while cost is a function of severity, health care costs average \$200,000 in the first year of injury.⁶ Inpatient hospitalizations in rehabilitation facilities account for an estimated 80% of these expenditures and, as in other areas of health care, providers of rehabilitation services have faced pressure to reduce care costs.⁷ The response to this pressure has been a drastic reduction in the length of stay, which has declined from 74 to 37 days from 1986 to 1996 in acute rehabilitation settings following injury.⁸

Shortened length of stays for rehabilitation potentially increase the risk of secondary complications post discharge for those receiving treatment for spinal cord injuries. The causal pathway is straightforward. The psychological and

physiological impact of spinal cord injuries is profound.⁹ As the length of time in rehab declines, less time is available for physical recovery, psychological adjustment, and education in how to cope with a changed health state. Many of those injured may not have had time to absorb adequate information about how to care for themselves, nor how to adapt to the health-related challenges that they will face. They may feel emotionally and psychologically unprepared to return home at discharge.¹⁰ Also, as a result of the altered timetable, case-based evidence from the disability community suggests that individuals return to their communities before their homes have been modified. Families and others likely to comprise the informal support network also will have had less time to adjust.

While the pathway between increased risk and shortened lengths of stay is clear, actual evidence documenting this relationship is scarce. Neither rehab providers nor insurers have any incentive to document that changes in length of stay have detrimental effects on patient outcomes. One small study has shown an association between rehospitalization rates for pressure ulcers and shorter lengths of stay.¹¹

Continuing rehabilitation once the patient has been discharged home is one way to counteract the effects of the decline in the length of stay. Aside from the creation of guidebooks for patients and caregivers, notably little work has been done in the area of preventing secondary conditions or promoting self-care through extended or innovative patient and caregiver education at home following discharge. Continued in-home education has the potential to reduce the incidence of secondary conditions and thereby increase health-related quality of life and reduce long-term care costs. One promising way to continue post discharge educational rehabilitation is through the use of technology.

Role of telehealth. Technology in various forms can link health care providers and patients for the purpose of exchanging health-related information. A number of labels now exist to categorize these exchanges.¹² Interactions that focus on medical issues and involve physicians fall under the heading of telemedicine, while initiatives that employ rehabilitation specialists and focus on restoration of function are known as telerehabilitation. Telehealth interventions specifically include prevention and management and involve an array of providers including non-medical professionals, such as psychologists and social workers.

The technology available to implement interventions under any label varies widely in features and costs. From

the least to most costly, current options include the (a) Plain Old Telephone System (POTS), (b) units that run over POTS offering image and sound, (c) integrated services digital networks (ISDNs) that allow for voice, video and data transmission over cable lines, and (d) wider bandwidth (T-1) technologies that require fiber optic cables to increase speed and volume capabilities for data transmission. An important distinction is whether the interactions occur in real time or whether information is passed through a store and forward approach. For example, depending on the technology, radiologists may provide simultaneous, real time confirmatory consults for primary care physicians or examine x-rays taken previously by primary care physicians that have been forwarded to them for diagnostic confirmation.¹³

While a number of technological options are available to link patients and providers, many other issues must be resolved before implementation of telehealth programs. Providers must guarantee patient confidentiality in the transmission and storage of information and at the time of service delivery, and must devise quality control standards and measures for services delivered. Both patients and providers must be willing to accept the new delivery modalities. A number of studies to date have documented patient and provider acceptance of telehealth technologies and the reliability of diagnoses (including dermatological and psychiatric) obtained from them.¹⁴ Providers also must establish eligibility criteria for the receipt of services by demonstrating the conditions under which patients benefit, and payers and providers must agree on reimbursement provisions once eligibility criteria are met. In addition, if health professionals are providing services across state lines, they likely will need to be certified for practice in both the state in which they live and the states in which patients to whom they provide services reside.¹⁵

Telehealth costs. Aside from provider-related issues, cost remains a critical factor affecting the introduction or general adoption of telehealth approaches. The General Accounting Office notes that while federal agencies in the US spent \$646 million on telemedicine projects from 1994 to 1996, rigorous evaluations of the cost and benefits of this technology are lacking.¹⁶ A key challenge in obtaining third-party reimbursement for these services is to demonstrate that telehealth interventions can substitute for traditional care, or that the addition of telehealth technology leads to future cost savings.

Initial research on telehealth care focused on its effectiveness, namely, can care of equal quality be deliv-

ered using this modality? Studies of interventions that incorporate a video component suggest that *virtual* visits offer an equivalent substitute for a range of home health nursing visits.¹⁷ One common use is for nurses to provide wound care and management using video equipment approved for dermatological diagnosis.¹⁸ The presumption in these cases is that substituting virtual visits for actual home visits will reduce costs.

Researchers have now begun to gather explicit evidence on the cost-effectiveness of telehealth interventions. Nurses in a Minnesota health maintenance organization, for example, used telemedicine visits to help elderly patients manage chronic conditions, such as chronic obstructive pulmonary disease and diabetes. During a three-month pilot phase, nurse visits increased with the use of video-based telemedicine, while physician visits decreased. Even though the nurse video visits were an addition to routine practice, overall patient costs declined by 29% due to the reduction in use of physicians. Patients were satisfied with the video-based visits and no changes in quality of care were observed.¹⁹

While video-based interventions are increasing in popularity, evidence related to the effectiveness of telephone follow-up is well established. Telephone-only follow-up for patients with chronic conditions, such as heart disease and high blood pressure, has been shown to improve medication compliance in relation to routine, face-to-face follow-up.²⁰ Pain management support has also been successfully provided to arthritis patients over the telephone.²¹ As a result of these successful telephone-only interventions, questions have arisen about the cost-effectiveness of more expensive technologies. The critical issue is two-fold: does introducing a video component generate additional, measurable benefits, and if so, does the size of the benefit justify the added cost?

Telehealth and people with SCI. People affected by spinal cord injuries are ideal candidates for telehealth interventions. The technology can be used to increase access to a range of health care professionals. It eliminates the need for transportation to a provider or facility for people for whom moving is difficult. Also, given that most rehabilitation facilities are located in urban areas, rural relocation can be particularly problematic. Returning home to a rural area likely means moving away from specialists and other health care professionals with expertise in spinal cord injuries.²² Through a telehealth approach, interventions can also be designed to complement and work within a patient's home environment. Working in the home environment is likely to be

While the injury is dramatic, people experiencing spinal cord injuries are fairly quick to stabilize physically, but psychological recovery is often a longer process.

extremely beneficial, as it is the immediate arena in which people with SCI must learn to function.

Shepherd Center project. We will discuss preliminary results from a longitudinal study examining the costs and outcomes associated with a randomized trial of telehealth interventions for people with severe mobility impairments resulting from spinal cord injury. The results must be viewed as preliminary because, while enrollment closed in September 2000 and all interventions had been completed at the time of writing, observation of participants is ongoing. Here we report on the intervention outcomes measured in terms of depressive symptoms, health-related quality of life, and number of days of hospitalization. The three-year project was funded in September 1997 by the Office of Child Development, Disability and Health, National Center for Environmental Health, Centers for Disease Control and Prevention. The broad study goal is to assess the impact of telehealth interventions on preventing secondary conditions and promoting self-care among people with spinal cord injuries.

The intervention examined here was conceived and developed by the telehealth staff at the Crawford Research Center of Shepherd Center. Shepherd Center was founded in 1975 to provide comprehensive rehabilitation services, including psychological, social, and vocational needs, to patients with spinal cord injury and is now the largest free-standing specialty hospital in the United States. The Center is a 100-bed facility that serves patients throughout the southeast US; it receives 80% of the acute, non-fatal spinal cord injuries occurring annually in Georgia. Shepherd Center also has expanded the population it serves to include those affected by brain injury, multiple sclerosis, and other neurological disorders. On average, Shepherd serves more than 800 inpatients and 14,000 outpatients per year. The Crawford Research Center at Shepherd was founded in 1995. A major initiative of the Center is its telerehabilitation program.

The current study builds on the results of a small case-control pilot conducted in 1996. That study demon-

strated that telehealth interventions can be used successfully to manage skin care and to promote general self-care among people with spinal cord injury. It also suggested that telehealth interventions may impact outcomes, such as depression and employment rates, which are not conventionally measured in relation to this technology. In addition, nurses throughout the pilot developed and refined patient intervention protocols used in combination with the telehealth technology. The Shepherd staff learned how to train patients and their caregivers in the use of video-based telehealth equipment. The results of the pilot study were published previously²³ and led to the formation of the investigation reported here.

METHODS

All participants in the telehealth trial were recruited from the Shepherd Center in Atlanta. Any patient from 18 to 60 years of age with a newly acquired spinal cord injury was eligible. Patients were excluded if they had a concomitant diagnosis of a brain injury, known active substance abuse, or if their level of mobility impairment level was mild. For example, people with spinal cord injuries were excluded if they were gaiting, meaning able to execute the sequence of motions required to move the body forward while simultaneously maintaining stability and balance. Participants also had to have a telephone and be discharged to the community, or to day hospital (considered community but not home). All participants were research volunteers and completed informed consent forms approved by both the Emory University and Shepherd Center Institutional Review Boards.

Intervention protocol. Once they agreed to participate, patients were randomly assigned to one of three telehealth intervention groups: video, telephone, or standard care. Participants in the video and telephone groups took part in individual educational rehabilitation sessions with a study nurse once a week for five weeks, then once every two weeks for one month. The sessions were in addition

to any other regularly scheduled care, such as the two-month post discharge visit. The content and structure of the education sessions for the two intervention groups were similar, except that the video group also saw real time images of the study nurse. The intervention sessions lasted a total of nine weeks.

For both the video and telephone groups, the educational sessions consisted of a structured review of skin care, nutrition, bowel and bladder routines, psychosocial issues and discussion of any equipment needs. The standard care group received the routine care offered by Shepherd Center, which requires patients to call the Shepherd help line if and when they need assistance prior to the regular two-month post discharge visit.

Two nurses conducted the interventions, and could make referrals to a mental health counselor or call in professionals, such as physical therapists, for consultations. Both were Certified Rehabilitation Registered Nurses and had extensive experience working in rehabilitation. The nurses worked with Shepherd Center educational staff in creating the intervention protocols that were tested and refined during the 1996 pilot study. The study nurses worked through many sessions together in an effort to standardize the general presentation and material covered. Nurses scheduled each session with patients individually and all sessions were conducted by a single nurse. The sessions were interactive with the nurse completing the protocol and the patient answering and asking questions. The sessions, on average, lasted approximately 30 to 40 minutes.

Videos versus telephones. The key feature of the video-based technology compared to the telephone-only is that video allowed the nurse and participant to see each other during the session. The video consultations took place over simple, compact equipment, roughly the size of a small personal computer, that operates over standard telephone lines. Participants in the video group and their family members, where appropriate, were trained in the use of the unit before the patient was discharged from Shepherd. A speakerphone was provided for those in the telephone group who were incapable of holding a telephone.

Prior to or shortly after discharge, the study nurse set up individual appointment times for those in the telephone and video groups. At the prearranged time, a telephone group participant answered the phone and completed the session. Video group participants, each at his or her scheduled time, ensured that the unit had been plugged into the telephone jack. When the phone rang, the participant or a family member, if needed, simply

pressed a button to establish voice and video contact. The participant saw the nurse on a small screen, and a camcorder attached to the unit transmitted the participant's image back to the nurse at the base station over the same telephone line. Technical staff were available to assist participants who encountered problems in using the equipment. At the end of the intervention period, participants were responsible for boxing and mailing the equipment back to Shepherd Center.

Data collection. Study nurses extracted demographic information and disability severity as indicated in the participant's chart. These data became part of the participant's study record. The measure of disability severity is the Functional Independence Measure (FIM) of physical and cognitive disability. The FIM covers 18 areas and assesses how much assistance is needed with a range of tasks, primarily Activities of Daily Living (ADL) self-care tasks, such as getting around, transferring in and out of the wheelchair, and bladder and bowel management. Assessments of communication and three areas of cognition are also included in the FIM. The measure is part of the Uniform Data Set for Medical Rehabilitation and is used as a basic indicator for severity of disability. The nurses also recorded notes during the intervention encounters that became part of the participant's clinical record.

Trained study interviewers, not associated with Shepherd Center, collected the outcome-related data, which was used to evaluate the effect of the interventions. These interviewers were not associated with Shepherd Center and were located at a separate institution. Follow-up interviews were conducted by telephone only and were completely separate from the intervention sessions. Follow-up interviews took place at week 5 during the intervention, at week 9 at the end of the intervention, and then on a monthly basis for at least one year of follow-up. The exact period of follow-up depended upon the time of enrollment. All participants will be followed for at least one year. All participants had completed the intervention for the analyses reported here by September 2000.

Study interviewers collected data on health care utilization, skin sores, employment status, and a self-report measure of handicap on a monthly basis. Information on health-related quality of life and depression were collected quarterly. The same data were collected for all participants, including the control group, regardless of group assignment.

Measuring quality of life. The Center for Epidemiologic Studies Depression Scale (CES-D), a 20-item scale,

documents the presence of depressive symptoms in the population, but not the cause or source of the depression. The initial CES-D interview took place at the end of the intervention, week 9, and these values were treated as baseline values.

The Quality of Well-Being Scale (QWB) measures health-related quality of life through participant self-report on functional performance in terms of mobility, physical activity, and self-care, and the occurrence of a range of symptoms present over the previous six days. The purpose of the scale is to capture in a single measure a subjective assessment of a person's health based on his or her functional performance. Values on the scale can also be used to calculate quality-adjusted life years (QALYs). QALYs are essentially years of crude survival adjusted for the quality of the survival from the individual's perspective. These measures can be used to compare the results of interventions within and across programs.

We present results for newly injured spinal cord injury patients discharged from the rehab center. They include scores for the CES-D and the QWB at baseline, at week 9, and at the end of the first year of follow-up, and average annualized number of days of hospitalization while enrolled in the study. The focus here on the CES-D and the QWB is to emphasize the path of secondary conditions, such as depression, and of health-related quality of life for people with primary disabling conditions. Healthy People 2010 requests that these outcomes be monitored.

Given the small sample size, we analyzed data using non-parametric methods, namely the Kruskal-Wallis test

for independent samples. Sample size calculations were based on pressure sore data from the 1996 Shepherd Center pilot study. The measures presented here should be viewed as preliminary results, as the study was not specifically structured to detect significant differences in the CES-D, QWB, or days of hospitalization. Health care utilization data, given the large associated variances, are seldom used as the basis for sample size calculations, nor were they here. Rather, this exploratory analysis may inform sample size estimates needed for future studies where the outcomes of interest are depressive symptoms, health-related quality of life, and utilization. The results should also be viewed as preliminary as all participants, while completing the intervention, have not yet completed one year of follow-up.

RESULTS

Table 1 provides demographic information on spinal cord injury participants discharged to the community. Our recruitment targets were 36 to 40 per group. Shepherd case managers recruited 36 participants for each of the video and telephone groups and 39 participants for the standard care group. The mean age of the sample was 35 years and did not vary significantly across groups. Sex and race did not vary significantly by group: overall, 80% of the sample was male, and 19% African American. Mean time enrolled at the time of analysis was 13 months. Where necessary, outcome variables were adjusted for duration of enrollment. Functional independence scores

Table 1. Characteristics of participants with spinal cord injuries, by distribution in three telehealth interventions, Shepherd Center, Atlanta, Georgia, 1998–2000

Characteristic	Video (n = 36)	Standard deviation	Telephone (n = 36)	Standard deviation	Standard (n = 39)	Standard deviation
Years						
Mean age.....	35	± 10.8	37	± 13.1	33	± 11.2
Percent						
Male	75		72		82	
African American	17		17		16	
Married.....	53		55		59	
Score						
FIM	91	± 27.5	91	± 26.5	82	± 34.3
Months						
Mean months in study.....	15	± 10.0	14	± 68.8	12	± 8.9

FIM = Functional Independence Measure

can range from 18 to 126 with higher scores indicating greater disablement. The average FIM at discharge was 88, suggesting substantial disability in terms of self-care. FIM discharge scores did not differ statistically by group, but were slightly lower for the standard care group.

Health-related scores are provided in Table 2. The QWB scores did not differ significantly at baseline, week 9. The average QWB score was 0.50, indicating that one year of survival with a mobility-impairing spinal cord injury is equivalent to a half year of life at full health or 0.5 of a quality-adjusted life year. QWB scores at week 52, or one year after discharge, had risen for both the video (0.03) and telephone groups (0.06), but fallen slightly for the standard care group (0.01).

The educational intervention, delivered via telephone or video, followed a single protocol. Thus, one analysis examined the intervention arms (video and telephone) together as one group compared the intervention to standard care. QWB scores for the intervention arms together at 0.53 (standard deviation ± 0.09) were significantly different at the 10% level compared to the standard care group at 0.48 (standard deviation ± 0.05).

The CES-D score can range from 0 to 60, with higher scores indicating the presence of more depressive symptoms. A score of 16 means the individual screens positive for depression. Scores across groups were not significantly different at week 9. The mean for the study population was 17.0 (standard deviation ± 9.47), with those in the telephone-only group exhibiting fewer depressive symptoms. Depressive symptoms declined for all three groups, with those in the video group continuing to exhibit more symptoms at one-year post discharge

than those in the telephone-only or standard care groups.

We calculated mean hospital days per year by dividing the total number of hospital days by time in the study and annualizing this figure for each participant. This approach adjusts for differential enrollment periods among participants. Nine of 36 participants were hospitalized in the video group, 11 of 36 in the telephone group, and 15 of 39 in the standard care group. Annualized rates of hospitalization by group were 0.39 for video, 0.80 for telephone, and 0.92 for standard care. Translated to an annual value, those in the video group averaged close to 3 days per year and those in the telephone group 5 days per year, while those in the standard care group averaged close to 8 days per year.

DISCUSSION

In-home telehealth interventions are promising ways to continue education and promote preventive self-care once a person with spinal cord injury returns to the community. The telehealth interventions described here are educational initiatives to promote rehabilitation following discharge after initial spinal cord injury. Telehealth approaches facilitate on-going education, required by people with spinal cord injury. People affected by SCI need assistance as they adjust to their new circumstances. They have experienced specific life-changing events that require them to develop new skills, and to establish different relationships with the health care system. Most people affected by spinal cord injury have not interacted previously with neurological specialists nor with the rehabilita-

Table 2. Results of quality of life measures at baseline and year one for telehealth study participants with spinal cord injuries, Shepherd Center, Atlanta, Georgia, 1998–2000

Intervention group	CES-D scale				Quality of well-being scale				Annual hospital days	Standard deviation
	Week 9	Standard deviation	Week 52 ^a	Standard deviation	Week 9	Standard deviation	Week 52	Standard deviation		
Video	19	± 8.5	17	± 14.0	0.50	± 0.08	0.53	± 0.12	3.0	± 8.9
Telephone.	16	± 9.9	9	± 8.8	0.48	± 0.06	0.54	± 0.07	5.2	± 14.7
Standard care	18	± 9.3	8	± 7.6	0.49	± 0.08	0.48	± 0.05	8.0	± 14.1

NOTE: Higher scores indicate more depressive symptoms are present.

^aValues were significantly different at the *P* < 0.10 level only.

CES-D = Center for Epidemiologic Studies Depression scale

tion and long term care systems. They have not experienced life with a chronic health condition that requires continual monitoring. While the injury is dramatic, people experiencing spinal cord injuries are fairly quick to stabilize physically, but psychological recovery is often a longer process. Thus, after the patient returns home, nurses can use the technology to continue education begun during the initial rehab stay. Reductions in length of stay have potentially increased the need for post-discharge education.

The intervention, delivered via telephone or video, warrants evaluation because it is a new, added service instituted, in part, as a response to market changes. The preliminary results here suggest that adding telehealth interventions may lead to a reduction in future hospitalizations in the first year after injury. Both the telephone and video group had lower rates of hospitalizations than the standard care group; specifically, rates of hospitalization in the video group were half those in the telephone group. One explanation for this differential may be differences in skin care practices among video and telephone group participants.

Much of the focus of the educational sessions was on appropriate skin care. Skin problems are a leading cause of rehospitalization post discharge. Explaining proper skin care, including prevention of pressure ulcers through weight shifts and body positioning and care of sores once they develop, may be best accomplished with visual aids. Observing care routines may have led to better skin care practices, thus reducing the need for hospitalization in relation to pressure sores or other skin-related issues.

The data here also suggest that telehealth interventions may produce benefits in terms of increased health-related quality of life that do not occur with standard care. For example, both intervention groups gained 18 days of quality-adjusted survival per year over the standard care group (0.05 QALYS x 365 days per year). Of note is that health-related quality of life gains were similar for the telephone and video groups.

The study also found a high rate of depression in the population. Symptoms of depression were reduced by the end of year one by 7 points in the telephone group and 10 points in the standard group, but only by 2 points in the video group. The reductions in the telephone and standard care groups are significant, as both groups moved from screening positive for depression at score 16 or above to no longer screening positive for depression. On average, members of the video group screened positive for depression at the end of year one. No obvious explanation emerges for the lack of remittance of symptoms among the video groups. Risk factors for depression and

the course it takes in individuals with spinal cord injury, along with anti-depressant use among them, are important areas for future research.

Limitations. The study has a number of limitations. First of note is the small sample size for the study. Second, for the results presented here, only 42% had been enrolled for one year, so the findings here must be viewed as preliminary. Analyses to confirm the preliminary results will take place as more data become available as participants reach the one-year mark. While the study population in terms of demographics was similar to the national spinal cord population, it should be noted that all recruits came from a single rehabilitation facility with its specific care practices. Also, nurses conducting the intervention were experienced in both rehabilitative care and telehealth technologies.

Potential benefits of telehealth intervention. During this study, nurses at Shepherd identified several issues that appear to have a substantial impact on patient responses to the intervention in the short run. Patient co-morbidities appear to affect the pace and nature of their adjustment to their changed circumstances and the services that they need. These co-morbidities may have existed prior to the injury or result from it. For example, heavy substance use may be related to the injury. If so, this behavior and its residual consequences are likely to need specific attention, as they potentially complicate adjustment to life with mobility impairment. Case report data on drinking-related accidents leading to spinal cord injury and longer term patient outcomes support this hypothesis.²⁴ The context of the injury itself can also play an important role in how people adjust. For example, one participant was driving the vehicle in which his wife and another passenger were killed. Dealing with the resulting psychological issues was as important in facilitating his rehabilitation as was addressing his physical impairments.

Telehealth interventions facilitate identification and treatment of issues such as these. Telehealth consultations are equivalent to face-to-face meetings in effect, so problems can be identified. Many telehealth approaches provide follow-up care where it did not exist before, so the chance of problem identification improves. Also, visits of this type are easier for the patient, as he or she does not have to travel to see a health care provider. Furthermore, as they can lead to early identification of problems that may be more costly if left untreated, the visits may be cost-saving.

To what degree telehealth interventions are self-financing or cost-saving is a key question. The study here provides preliminary evidence in the affirmative for a specific intervention supplying additional education post discharge for SCI patients. In this case, if the telehealth program costs, particularly those related to video-based interventions, are more than offset by a reduction in future hospital costs, then the additional services provided post discharge will pay for themselves overall. In certain analyses, this calculation can be complicated by the issue of who pays.

An individual's insurance status may change after injury. For example, a person who is employed at the time of injury may not be able to return to work and, ultimately, may shift to some other insurer, such as

Medicare, for long-term disability. If the insurer at the time of injury is not responsible for the individual in the medium to long term, that insurer has no incentive to invest upfront in care, such as telerehabilitation, that affects longer term outcomes. The issue of who pays often affects cost-effectiveness assessments of prevention-based programs; telehealth interventions are likely to face similar scrutiny. As this was a research study to examine the effectiveness of the intervention and its impact on overall cost, the issue of "who pays" was not addressed here. Finding mechanisms through which to finance telerehabilitation initiatives that are likely to be cost-saving, such as the intervention described here, is an area for future research.

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