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Predicting recovery using continuous low back pain outcome measures

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Abstract

Background context: There is a lack of research evaluating multiple follow-up visits, specifically when using continuous outcome measures. Continuous outcome measures with several follow-up assessments would allow us to evaluate rate of recovery.
Purpose: To predict low back pain outcomes based on the quantification of initial conditions.
Study design/setting: This was a prospective study where patients were enrolled within the first month of low back pain symptoms and evaluated for 3 months. Patients were recruited from several primary care facilities.
Patient sample: Thirty-two patients with local low back pain symptoms were recruited for the study.
Outcome measures: There were four major outcome measures, including functional performance probability, symptom intensity, impairment of activities of daily living, and a summary outcome measure.
Methods: Regression models were constructed using the initial conditions, including psychological, psychosocial, physical workplace, and personal factors, to predict the rate of recovery for each outcome measure.
Results: Twenty-eight patients completed the study. The r^2 value for the rate of recovery regression models were 0.77 symptom intensity prediction, 0.85 activities of daily living prediction, 0.87 functional performance probability prediction, and 0.96 summary outcome measure prediction. Two functional performance patterns of recovery were found, including a steady improvement and a large jump in improvement. A discriminant function model identified the pattern of recovery in 91% of cases given initial conditions.
Conclusions: Continuous outcome measures can be accurately predicted given the initial conditions.

Keywords: Low back pain; Quantification; Outcome measures

Introduction

Low back disorders (LBDs) are one of the most common ailments plaguing society today. According to the epidemiological literature, lifetime prevalence may be as high as 80% [1]. Fortunately, nearly 90% of those with LBD will recover in 2 to 8 weeks regardless of treatment. However, there is a lack of research evaluating multiple follow-up evaluations, which would allow researchers to evaluate the rate of recovery pattern. It is hypothesized that predicting the rate of recovery pattern based on the patients' initial condition may improve health care by providing a realistic expectation of recovery for the patient, thereby alleviating anxiety about the length of recovery. In addition, it may also predict the 10% of patients at risk for developing chronic low back disorders.

There are a plethora of outcome studies evaluating low back pain recovery. The most common outcome measures in the literature include return to work [2–21], symptoms [2,9,22–32], activities of daily living (disability questionnaires) [10,12,16,23,25,26,33–38], and functional capacity [6,22–24,35,39–46]. Typically, these outcome measures have been assessed as dichotomous measures indicating whether a patient has recovered. Symptoms, activities of daily living, and func-

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tional capacity or functional performance may be scored as continuous or interval outcome measures. It is hypothesized that continuous or interval outcome measures may provide more quantitative information regarding the extent of recovery or residual impairment than traditional dichotomous measures.

Factors that influence recovery

Patients often want to know how long it will be until they recover or are able to return to specific activities. Providing a realistic expectation of the length of time to recovery may reduce patient anxiety and enhance patient recovery. The length of time required for low back pain recovery may be influenced by several categories of factors, including psychological factors, psychosocial workplace factors, physical demand workplace factors, and personal factors.

Psychological factors

The psychological measure of depression has been shown to influence return to work [14,21,47] and symptoms [4,17,27,44]. In addition to depression, psychological measures of anxiety [27,48,49] and stressful life events [40–50] have also been shown to influence symptoms. There is a lack of research evaluating the influence of psychological measures on activities of daily living or functional performance outcome measures.

Psychosocial factors

The psychosocial measures of job satisfaction [51–53] and job control [52] have been shown to influence return to work. Symptoms may be influenced by job enjoyment [51], relations with supervisors [30,54,55], job control [52], mental stress [56,57], and mental workload [30,58]. These studies illustrate the multitude of psychosocial factors that may influence traditional dichotomous outcome measures. It is postulated that these types of factors may also influence continuous outcome measures.

Physical workplace demands

Physical workplace demands have been found to influence return to work. Lifting [58], twisting [59], weight of lift [52,59], and posture [58,59] have been shown to influence return to work. Because physical job demands influence return to work, these measures should be assessed when evaluating recovery using other outcome measures.

Personal factors

There are several personal factors that have been evaluated in the literature. Age has been shown to influence return to work [60]. Cultural factors, personal philosophy, and monetary factors may also influence symptoms [61,62]. Smoking habits have been shown to influence symptoms [48,54]. Thus, these personal factors should be monitored when evaluating outcome measures.

Research void

Three of the four most commonly used outcome measures in the literature may be quantified as continuous measures. Continuous measures are those that can take on any numerical value [63]. There is a void in the literature quantifying low back pain recovery using continuous outcome measures. Furthermore, there is a lack of research evaluating the effects of factors on continuous outcome measures, which have been shown to influence traditional dichotomous outcome measures. Hence, the first goal of this project is to quantitatively assess recovery using continuous outcome measures. The second goal is to predict recovery given the initial conditions.

Methods

Approach

A prospective study was designed to monitor acute low back pain recovery using various outcome measures at fixed follow-up times for a period of 3 months. The study was limited to 3 months, because it was hypothesized that most of the changes in outcome would occur during the first 3 months of recovery for patients with acute low back pain. Four continuous outcome measures were used: present pain intensity, activities of daily living, the kinematic measure of functional performance probability, and a summary outcome measure. The functional performance probability outcome measure was generated from the model developed by Marras et al. [64]. Personal, psychological, psychosocial, symptom quality, physical demand workplace factors, and additional kinematic measures were evaluated as baseline measures. It is hypothesized that this prospective approach evaluating continuous measures of symptoms, activities of daily living, and functional performance will provide a more quantitative understanding of recovery than traditional dichotomous outcome measures.

Participants

Thirty-two participants were recruited for the study. All participants had local low back pain symptoms with no radicular symptoms (Quebec Task Force Category 1) [65] and were recruited within the first month of their symptoms. The participants were recruited from several local primary care facilities. A single physician screened all patients at the initial evaluation to ensure appropriate diagnostic symptoms. All participants were paid $10 per visit and a $50 bonus for completing all the visits. The protocol for the study was approved by The University's Human Subjects Review Board.

Experimental design

This was a prospective study where outcome was assessed every 2 weeks for 3 months (six visits).

Outcome measures

There were 4 major outcome measures. The outcome measures included present pain intensity, activities of daily living, functional performance probability, and a summary outcome measure as listed in Table 1. The summary outcome measure was created with a three-step mathematical process. First, present pain intensity, activities of daily living, and functional performance were translated to a 0 to 1 scale. Because present pain intensity and activities of daily living scores decrease with improvement and functional performance probability increases with improvement, the second step was to reverse score the present pain intensity and activities of daily living scores. Thus, the three outcome measures were all on a 0 to 1 scale, where 1 indicated complete recovery. Finally, the present pain intensity, activities of daily living, and functional performance probability were averaged to create the summary outcome measure. In this manner the present pain intensity, activities of daily living, and functional performance probability were all equally represented in the summary outcome measure.

Baseline measures

Table 1 lists all the baseline measures by category. The categories of baseline measures included symptom quality, kinematic, personal, psychological, psychosocial, and physical workplace factors. The baseline kinematic measures were from the functional performance cardinal plane protocol.

Equipment

The lumbar motion monitor (LMM), a tri-axial electrogoniometer, was used to quantify functional performance [66]. The LMM is attached to the person using orthoplast, as shown in Fig. 1. An oscilloscope provided visual feedback for the asymmetric control tasks. A comparator circuit provided auditory feedback for the subject as well as the experimenter. A portable computer was used for collecting and storing the data.

Questionnaires

The McGill Pain Questionnaire (MPQ) was used to evaluate pain symptoms [67]. The present pain intensity score from the questionnaire was the major symptom outcome measure. The qualities of pain symptoms (sensory, affective, evaluative, total) assessed using the MPQ were used as baseline measures. The impact of low back pain on activities of daily living was evaluated using the Million Visual Analog Scale (MVAS) [68]. Depression was measured using the depression section of the symptom checklist 90 (SCL-90) questionnaire [69]. The perceived stress questionnaire was used to measure stress [70]. The National Institute for Occupational Safety and Health (NIOSH) Job Stress Questionnaire was completed to evaluate psychosocial aspects of the patient's work and personal life [71]. The physical demands of the patient's job were assessed with the questionnaire from the NIOSH small appliance study [72]. All these questionnaires have been validated in the literature with the references cited above.

Functional performance

The functional performance evaluation included two protocols. The first was an asymmetry protocol where participants controlled their twisting position [64,73,74]. Each participant was instructed to "flex and extend your trunk as fast as you can comfortably while maintaining your twisting position." The controlled twisting positions were zero, 15 degrees clockwise and counterclockwise, and 30 degrees clockwise and counterclockwise. The asymmetry protocol results were used as the functional performance outcome measure.

The baseline functional performance measures were assessed with a second protocol. The second protocol was the cardinal plane protocol, which included three tasks [75].

Table 1
List of outcome and baseline measures evaluated by category

Repeated measures	Categories of baseline measure				
Continuous outcome measures	Symptom measures	Kinematic measures	Psychological and personal factors	Psychosocial workplace factors	Physical workplace factors
Present pain intensity	Pain qualities	Range of motion	Age	Social support	Lifting
Activities of daily living	MPQ affective	Sagittal	Gender	Boss	Pushing/pulling
(MVAS)	MPQ sensory	Lateral	Education	Coworker	Exposure to vibration
Functional performance	MPQ evaluative	Twist	Marital status	Family	Standing
probability	MPQ total	Velocity	Previous history	Job satisfaction	Sitting
Summary outcome		Sagittal	Compensation	Role conflict	Kneeling
		Lateral	Litigation	Role ambiguity	Bending forward
		Twist	Smoking habit	Job control	Bending side to side
		Acceleration	Depression	Quantitative workload	Twisting
		Sagittal	Stress	Variance of workload	Overall physical effort
		Lateral	Anthropometry		
		Twist	Trunk breadth		
			Trunk depth		
			Trunk length		
			Height		
			Weight		

MPQ = McGill Pain Questionnaire; MVAS = Million Visual Analog Scale.

Fig. 1. Lumbar motion monitor on a participant.

The participants were instructed to "bend as fast as you can comfortably," in the sagittal, frontal, and transverse planes of the body.

Procedure

All participants were screened by a single physician (PG) before being accepted into the study. Once the participant was approved for the study, the participant completed the human subjects consent form, all the questionnaires, and the functional performance evaluation. This procedure was followed at all the visits.

Data analysis

Questionnaires

The MPQ, MVAS, depression and stress questionnaire data were entered into a database. The MPQ scores included present pain intensity, total word count, sensory word count, affective word count, and evaluative word count. The present pain intensity score was used as an outcome measure, whereas pain qualities of sensory word count, affective word count, evaluative word count, and total word count were baseline measures. The present pain intensity score is independent of the four word count measures. The MVAS and stress scores were the sum of all the questions. The depression score was the mean of all the questions. The NIOSH job stress measures were averaged across all the questions.

Functional performance

The kinematic measures from the LMM were calculated with validated techniques [70]. The output from the asymmetry protocol included range of motion (ROM), flexion velocity, extension velocity, flexion acceleration, and extension acceleration from each of the planes. The data from this test were analyzed using a model that distinguishes between controls and patients [64]. The model generates a probability for functional performance of being in the control group (i.e., recovery). The model has a sensitivity of 86% and specificity of 94%, indicating accurate classification of patients and controls [64]. The functional performance probability from the asymmetry protocol was used as the functional performance outcome measure.

The cardinal plane functional performance protocol results included ROM, velocity, and acceleration for all three planes of the body. A database of controls (those without history of back pain) was used to normalize the data by age and gender. The output from the cardinal plane tasks was expressed as a fraction of the control group performance. The cardinal plane protocol performance was used as a baseline measure.

Statistical analysis

Descriptive means and standard deviations were calculated by visit. Regression analysis was used to predict continuous outcome measures of present pain intensity, activities of daily living, functional performance probability, and summary outcome measure given the initial conditions. Model development was based on an initial stepwise regression procedure using SAS with all variables in Table 1 as potential inputs to the model. A regression model of the stepwise results was run in order to evaluate the residual plots.

Results

Twenty-eight of the initial 32 participants completed the study. The average age of the participants was 35 years with a standard deviation of 12 years. Sixty-four percent of the participants were male. Four participants dropped out for reasons not associated with the study. Table 2 lists the means and standard deviations for each of the major outcome measures as a function of time. On average, the participant's first visit was 2 weeks into their symptoms; therefore, Table 2 starts with time at 2 weeks. All the outcome measures showed significant improvement over time. However, there was significant variation between subjects.

Regression models predicting recovery for each outcome measure

The objective of these models was to predict the quantity of recovery given the initial conditions as well as a specific

Table 2
Means (standard deviations) for the four major outcome measures as a function of time

	Time (weeks)					
Outcome measure	2	4	6	8	10	12
Present pain intensity (0–5)	2.4 (1.06)	1.6 (0.99)	1.1 (1.1)	0.85 (0.8)	0.8 (1.1)	0.51 (1.1)
MVAS (0–150)	75.6 (21.0)	55.5 (27.4)	44.9 (34.7)	37.9 (31.6)	31.5 (33.1)	25.0 (33.5)
Functional performance probability (0–1)	0.09 (0.14)	0.22 (0.25)	0.38 (0.32)	0.51 (0.33)	0.56 (0.32)	0.65 (0.32)
Summary outcome (0–1)	0.37 (0.11)	0.51 (0.16)	0.62 (0.22)	0.69 (0.21)	0.73 (0.22)	0.79 (0.23)

MVAS = Million Visual Analog Scale.

length of time. The visit or time parameter is between 1 and 6. A visit value of 1 would indicate the initial visit within the first month of symptoms. The second visit [2] would be 2 weeks later, and 3 would be 2 weeks after visit 2 and so forth. The models would not apply to predicting recovery beyond 3 months. The inclusion of visit or time in all the models suggests that there is a natural improvement trend in all the recovery measures over time.

Model predicting present pain intensity recovery

Table 3 lists the model parameters, standard error, *P* values, partial r^2 and model r^2 for the model predicting present pain intensity recovery. The model consists of visit, trunk breadth, MPQ affective score, job satisfaction, and tobacco usage. Trunk breadth accounted for over 50% of the variance in the rate of recovery model. Biomechanically, a larger trunk breadth may create higher levels of spinal loading, which may cause symptoms to persist longer. The inclusion of MPQ affective score suggests that specific qualities of pain predict the intensity of pain in the future. The MPQ affective score accounts for less than 10% of the variance in the model. The psychosocial measure of job satisfaction may be predictive of symptoms because, according to the gate theory of pain, feelings about work influence pain perception [61]. Tobacco usage may be included in the model because it has been shown to influence nutrients, which may inhibit healing [62]. The personal, psychosocial, and symptom factors each account for a different component of present pain intensity recovery and combine to provide a model with an r^2 of 0.77.

Model predicting activities of daily living recovery

Table 3 also lists the variables, parameter estimates, standard error, and *P* values for the regression model predicting MVAS outcome across all visits. The model has an r^2 value of 0.85. The model consisted of initial present pain intensity, MPQ affective score, job control, sagittal ROM, and depression. The present pain intensity score had a partial r^2 of 0.7010, indicating that the intensity of pain is predictive of how much pain will interfere with activities. The model also included sagittal ROM, which may be predictive of MVAS, because participants with less range of motion may be more cautious when performing daily activities resulting in higher levels of impairment on the MVAS. The initial depression score was also included in the model. It is hypothesized that the inclusion of depression not only supports the psychological influence on pain, as suggested in the gate theory, but also indicates that depression may result in self-imposed limits of daily activities. The psychosocial measure of job control was also in the model predicting MVAS recovery. It is hypothesized that the more job control a person has, the higher the person's ability to minimize the risk of exacerbating symptoms, which may result in less symptoms, which in turn causes lower impairment of activities of daily living scores. The model variables combine symptoms, functional performance, and psychosocial and psychological factors in order to provide an accurate prediction of MVAS recovery. The combination of factors illustrates the complex nature of low back pain recovery.

Model predicting functional performance probability recovery

The model contains visit, initial twisting acceleration, job satisfaction, and MPQ affective scores, as listed in Table 3. Twisting acceleration has a partial r^2 of 0.7140, indicating it accounts for a large percentage of the variance. It is hypothesized that inclusion of initial twisting acceleration is the result of the fact that twisting requires more motor control than sagittal or lateral tasks and, therefore, it is a more affective predictor of recovery. Also, acceleration has been shown to distinguish between controls and patients more effectively than range of motion or velocity [75]. The inclusion of the MPQ affective score suggests that subjective pain qualities influence performance recovery. It may be theorized that certain qualities of pain inhibit functional performance. Therefore, this parameter is predictive of functional performance recovery. The psychosocial measure of job satisfaction was also incorporated in the model. Thus, job satisfaction explained some part of the variance in functional performance recovery not accounted for by MPQ affective score or initial twisting acceleration. Collectively, the psychosocial, symptom, and functional performance measures were used to predict functional performance probability with adjusted r^2 of 0.87.

Model predicting summary outcome measure recovery

The summary outcome measure model listed in Table 3e factors, including visit, twisting acceleration, MPQ affective score, job satisfaction, and overall physical demands of the job. Interestingly, the summary outcome measure was the most accurately predicted outcome measure. This may be because of the complex nature of the summary outcome measure and its correlation to the complexity of low back pain recovery.

Table 3
Rate of recovery regression model results for each continuous outcome measure

Outcome measure	Model variables	Parameter	Standard error	*P* value	Partial r^2	r^2
Present pain intensity	Trunk breadth	0.0383	0.0063	.0001	0.5282	0.7756
	Visit	−0.3520	0.0362	.0001	0.1255	
	MPQ affective	0.3888	0.0516	.0001	0.0651	
	Job satisfaction	0.3604	0.0800	.0001	0.0305	
	Tobacco usage	0.6581	0.1506	.0001	0.0263	
MVAS	Present pain intensity	18.7061	1.6085	.0001	0.7010	0.8534
	Visit	−8.6689	0.9667	.0001	0.0503	
	Depression	8.1577	2.2624	.0004	0.0408	
	Sagittal range of motion	30.4211	4.0499	.0001	0.0440	
	MPQ affective	5.5142	1.5218	.0004	0.0113	
	Job control	−3.6360	1.4130	.0110	0.0060	
Functional performance probability	Twisting acceleration	1.2952	0.0967	.0001	0.7140	0.8744
	Visit	0.1022	0.0074	.0001	0.0748	
	Job satisfaction	−0.1179	0.0168	.0001	0.0480	
	MPQ affective	−0.0779	0.0109	.0001	0.0376	
Summary outcome measure	Visit	0.0893	0.0054	.0001	0.8614	0.9634
	Twisting acceleration	0.7737	0.0525	.0001	0.0721	
	MPQ affective	−0.0476	0.0074	.0001	0.0103	
	Job satisfaction	−0.0571	0.0121	.0001	0.0049	
	Overall physical demands	0.0652	0.0065	.0001	0.0147	

MPQ = McGill Pain Questionnaire; MVAS = Million Visual Analog Scale.

Discussion

Summary of predictive outcome models

The results of this study illustrate that recovery can be accurately predicted as a continuous outcome measure. The model components predicting outcome show that functional performance, present pain intensity, activities of daily living or disability, and a summary outcome measure are all influenced by a combination of factors. The specific variables incorporated in the models changed as a function of the outcome measures. However, three specific variables consistently appear in the models predicting outcome regardless of the particular recovery measure being predicted.

The most frequent factor in the regression models was the MPQ affective score, a symptom quality measure. It was a predictor in all four regression models. However, it explained less than 10% of the variance in all the models, as indicated by the partial r^2 in Table 3. Melzack and Wall [76] indicated that prolonged pain symptoms were usually characterized by a higher percentage of affective words. This may explain why the MPQ affective score was predictive of present pain intensity and MVAS, but it does not provide an explanation for its importance in predicting functional performance probability. Melzack and Wall [76] suggested that certain dimensions of pain were perceived in different parts of the brain. Therefore, it may be hypothesized that the affective aspects of pain are perceived near the motor cortex and may influence motor coordination. This may provide one explanation for how the MPQ affective score influences both subjective and objective measures of recovery.

Psychosocial measures were also in all four regression models. However, the specific variable was not consistent. In three of the four models job satisfaction was the psychosocial measure, whereas in the fourth model job control was the psychosocial factor. The partial r^2 values indicate that job satisfaction and job control explained less than 10% of the variance in the models predicting recovery. The psychosocial measure did not account for a large percentage of the variance. However, it is important to consider these factors in recovery, because psychosocial factors influence all the outcome measures.

Functional performance measures appear in three of the four models. However, the specific variable in each model was not consistent. Twisting acceleration was in the functional performance probability and summary outcome recovery models. The MVAS measure of recovery incorporated the sagittal ROM. Previous research has shown that higher order motion measures, such as acceleration, are more effective measures for distinguishing between controls and patients, which may explain why acceleration is in more models than ROM [73–75,77].

Table 3 lists the r^2 values for each of the four outcome measures. Table 3 shows that the two subjective outcome measures (MPQ and MVAS) had the lowest r^2 values, the functional performance probability measure had a higher r^2, and the summary outcome had the highest r^2 values. This indicates that the subjective measures were not as accurately predicted as the objective measure. The lower r^2 values found for MPQ and MVAS measures may be the result of the high variability found in subjective measures compared with objective measures. Thus, of the single measure outcome tools, the functional performance probability was the most accurately predicted. It is hypothesized that the summary outcome measure was the most accurately predicted of all the outcome measures, because it incorporated both the subjective and objective outcome measures.

Rate of recovery pattern

A continuous outcome measure provides more quantitative information than a dichotomous measure of outcome, such as return to work. Multiple observations of a continuous outcome measure allow us to evaluate the rate of recovery pattern. Fig. 2 illustrates two types of recovery patterns: 1) steady improvement, and 2) large jump observed in the functional performance probability of recovery. In this study 16 patients show trends of improvement similar to the steady improvement pattern shown in Fig. 2, whereas nine patients showed improvement similar to the large jump pattern. The differences in the pattern of recovery may be the result of the severity of injury at the neural level. The motor control literature discusses the development of preprogrammed muscle activation patterns to generate specific movements [78,79]. It is hypothesized that those with a large jump recovery pattern may have inhibited the motor program, whereas those with a steady rate of improvement may be building a new neural program.

A discriminant function model was created to predict which recovery pattern group a participant would be in given their initial conditions. The discriminant function model correctly classified 94% of the steady improvement group and 89% of the large jump group. Three initial condition measures were used to predict the two patterns of recovery, including age, present pain intensity, and twisting acceleration. The age factor in the rate of recovery is consistent with the motor development literature [79,80]. The twisting acceleration was twice as high in the large jump group compared with the steady improvement group. The difference in twisting performance between the two groups may indicate that the steady impairment group lost more fine motor control necessary for twisting. The average initial present pain intensity in the steady improvement group was 2.4 compared with 1.8 in the large jump group. The means indicate that the steady improvement group may have been more severely injured than the large jump group. This supports the hypothesis that more severely injured people are building new neural programs resulting in inclusion in the steady improvement group [79]. Note that only 25 subjects were used in this analysis. The three participants not included showed no improvement during the study.

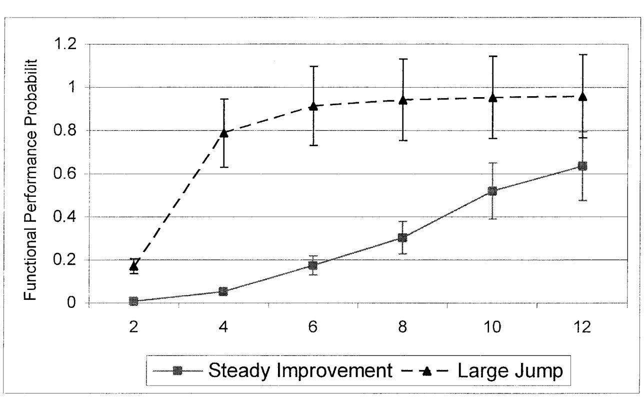

Fig. 2. Functional performance rate of recovery patterns.

Continuous functional performance probability outcome measures can be accurately predicted and provide more quantitative information on the extent of recovery than traditional dichotomous outcome measures. The regression and discriminant function models can be used in conjunction to indicate who will recover and how fast that person will recover. The regression model may identify the 10% of the population at risk for becoming chronic low back pain cases at their initial evaluation. Further studies are needed to determine whether changes in treatment may minimize the risk for developing chronic low back pain. The ability to indicate how long the patient will have symptoms and the amount of functional performance decrement may enhance the recovery process by reducing patient anxiety.

Limitations

This study had a small sample population. Further study is needed to validate the existing models. Second, additional diagnostic categories of low back disorders may be evaluated to quantify differences in recovery resulting from diagnostic group. Finally, studies of this nature may be done to evaluate the effectiveness of different treatment programs and the most efficient number of treatments.

Conclusions

Continuous outcome measures of present pain intensity, functional performance probability, and MVAS can be accurately predicted. The models predicting LBD recovery suggest an interactive process of recovery between symptoms and functional performance measures. In addition psychosocial measures were predictive of all outcome measures. The objective functional performance probability was the single measure outcome tool that was most accurately predicted given the initial conditions. The rate of recovery pattern can be predicted from initial conditions.

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Spinepost

One Hundred Twenty Years Ago in Spine

Jean-Martin Charcot [1], perhaps the world's first professor of neurology, described the peculiar arthropathy of spinal etiology that bears his name. He stated that "behind the disease of the joint there is a disease far more important in nature, which in reality dominates the situation—sclerosis of the posterior columns." He remarked upon the relationship to Pott's paraplegia, acute myelitis, and cord injury. Curiously, he did not specifically mention syphilis, a common cause in his day, nor did he recognize the association with diabetes, a common modern day cause. He did describe the arthropathy in the spine as well as in peripheral joints. Charcot had a sustained interest in many forms of arthritis about which he published from 1867 through 1887. He was not the first to describe arthropathy of spinal origin (probably done by John K. Mitchell [2] of Philadelphia in 1831), but the 1881 translation of Charcot's teachings on the subject made the disease known and secured the eponym "Charcot joint."

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