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Functional rehabilitation of low back disorders

S. TAIMELA [1, 2], S. NEGRINI [3, 4], C. PAROLI [5]

[1]*Department of Physiology*
Kuopio University, Kuopio, Finland
[2]*DBC International Ltd., Vantaa, Finland*
[3]*ISICO (Italian Scientific Spine Institute)*
[4]*Fondazione Don Gnocchi, ONLUS, IRCCS, Milan, Italy*
[5]*Unit of Rehabilitative Medicine*
Department of Rehabilitation
"Destra Vecchia" Hospital, Pieve di Coriano (MN), Italy

Musculoskeletal disorders of which low back pain (LBP) accounts for more than 50% are now the most common cause of chronic incapacity in industrialized countries. The traditional approach in looking for the reason (etiology) for musculoskeletal disorders is to search structural failures but, in most cases, it is difficult to find an explicit reason for back pain. Many scientists now consider spine disorders as multifactorial, bio-psycho-social problems. Pain has clear effects on motor control. Therefore, LBP can also induce changes in neuromuscular control and motor performance, *i.e.,* causing various functional deficits. Another feature, which deserves special consideration with reference to back problems, concerns the numerous psychological factors, which are involved in mediating the relationships between physical impairment, pain and disability. The new scientific knowledge on functional deficits is increasingly being transferred to clinical applications, where the aim is to reverse them with physical rehabilitation. As a result of the recognition of the behavioral (psychological) problems with LBP, psychological, behavioral and educational interventions are commonly combined with the physical rehabilitation for LBP also. Basically, functional rehabilitation includes systematic quantification of both the physical function and psychological factors, which drive the therapeutic process. The exercises used in the functional rehabilitation usually revolve around the treatment of the spine as a functional unit. Thus many programs for functional rehabilitation use rehabilitation equipment (iso-inertial/isokinetic) by properly trained physiotherapists. However, some centers use regular fitness equipment or aerobics-type exercises. Furthermore, some relaxation and ergonomic exercises are typically proposed, and psychological support provided along the treatment. There exists both an outpatient and an inpatient functional rehabilitation approach. They are described in the paper together with the first results obtained in Italy with the outpatient approach.

Key words: **Rehabilitation - Pains, low back - Musculoskeletal diseases.**

Address reprint requests to: S. Negrini, ISICO, VIa Carlo Crivelli 20, 20122 Milan, Italy. E-mail: stefano.negrini@isico.it

Musculoskeletal disorders — of which low back pain (LBP) accounts for more than half — are now the most common cause of chronic incapacity in industrialized countries. People with chronic LBP make up a minority of back pain sufferers, but because of costs related with repeated treatment, long-term work absence and social support, they account for the majority of the economic costs related to back pain. The statistics concerning the economic burden of LBP are shocking. For example, according to the records of the Social Insurance Institution, in the year 2002 there were about 130 900 sick leaves due to musculoskeletal disorders, 56 300 due to mental health problems and 20 200 due to cardiovascular diseases in Finland (population 5.1 million). The Social Insurance Institution compensated 4.5 million days on sick leave due to musculoskeletal disorders, 3.5 mil-

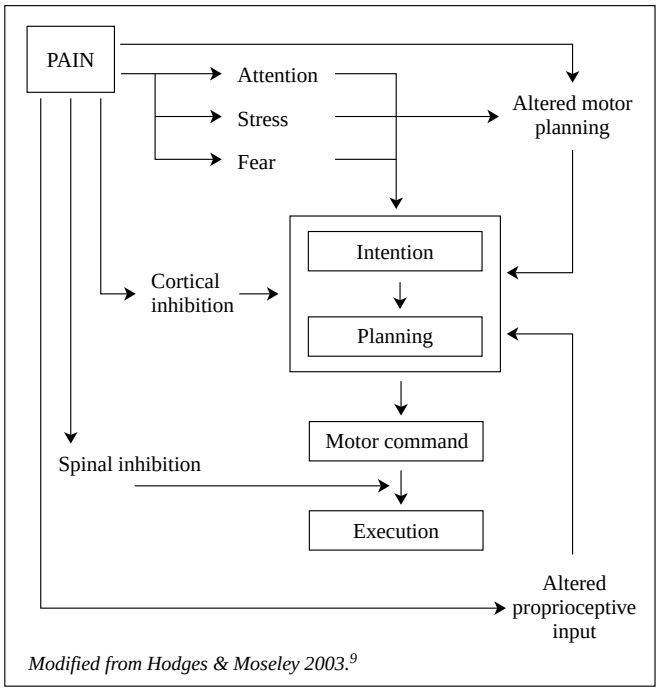

Figure 1.—Potential mechanisms for the effect of pain and fear on motor control. Modified from Hodges *et al.*[30]

lion days due to mental health problems and 1 million days due to cardiovascular diseases. The corresponding monetary compensation for sick leaves due to musculoskeletal disorders was € 195 million. More specifically, € 90 million were due to spinal disorders and even more detailed, € 40 million were due to non-specific low back pain. The incurred costs of rehabilitation of low back pain amount about € 33 million yearly. Unfortunately, despite rehabilitation, the patients do not always return to work. According to the statistical yearbook of pensioners in Finland, in 2001 there were about 32 500 people on disability pension due to low back pain problem. The Central Pension Security Institute has calculated that an average disability pension due low back problems is € 11 820 in a year. Consequently, it is estimated that about € 400 million are paid every year in disability pensions due to low back pain. This is 2 times higher than the direct health costs (medication and health care), which are estimated to be some € 200 million a year.[1] Thus, there is a clear need for effective rehabilitation methods for chronic LBP patients.

The traditional approach in looking for the reason (etiology) for musculoskeletal disorders is to search structural failures. Evolution of modern diagnostic tools such as MRI and CT has made it possible to locate abnormalities of the smallest scale. However, LBP poses a challenge for this approach. Abnormal findings in the spine are about as frequent among back-healthy controls as among patients, and there are severely disabled back pain sufferers among whom we cannot find structural abnormalities regardless of the level of advancement in the diagnostic tools. In most cases it is difficult to find an explicit reason for back pain. Many scientists now consider spine disorders as multifactorial, bio-psycho-social problems, *i.e.*, prolonged pain tends to develop into a combination of physical, psychological and social disabilities, potentially leading to absence from work and early retirement.

Pain has clear effects on motor control. Therefore, LBP can also induce changes in neuromuscular control and motor performance, *i.e.*, causing various functional deficits. The appropriate muscular control and movement as well as posture perception are of vital importance in preventing low back injury. The protection against injury requires anticipation of events and adequate muscular responses. Both abnormal and missing protective reflexes can potentially lead to trauma or microtrauma of muscles, nerves, intervertebral discs and ligamentous spine during loading. Recent publications on back pain patients have reported features such as long psychomotor reaction times,[2-4] abnormal balance and postural control,[5, 6] delayed spinal reflexes,[7-9] abnormal trunk muscle co-ordination,[10-12] poor proprioception of the trunk position,[5, 8, 13, 14] partly irreversible atrophy of the intersegmental muscles supporting the spine,[15, 16] and abnormal muscle endurance.[17-19] The role of these abnormalities cannot be ruled out in the etiology of spine disorders, but it is likely that the causality is the other way around. A likely explanation is that pain, regardless of its origin, disturbs both voluntary and non-voluntary movement control, and induces fears, leading to cumulative microtrauma, overloading, muscle fatigue and avoidance behavior. The subsequent outcome is a vicious circle with more pain and suffering. However, there is increasing evidence that these functions can be recovered by treatment and restored by active rehabilitation.

Another feature, which deserves special consideration with reference to back problems, concerns the numerous psychological factors, which are involved in mediating the relationships between physical impairment, pain and disability. It has been shown that

fear-avoidance beliefs about work and physical activity, catastrophizing, the lack of belief in one's own ability to manage pain, cope and function, and self-efficacy beliefs are all significantly related with disability in chronic pain patients.[20-28] Both experimental and clinical studies have shown that fear and the avoidance of movement influence also the experience of pain and chronic pain disability.[28] Using multivariate analysis, pain-related fear has been shown to be one of the most important factors explaining disability.[22, 27, 29] Some authors have even suggested that fear of pain and (re)injury may be more disabling than pain itself,[21, 28] which is not, however, supported by clinical data in other studies, where characteristics of pain, especially pain intensity, have had a greater influence on disability. Studies that have used multivariate analysis to predict disability have shown that pain normally explains the greatest or second greatest proportion of the variance.[22, 24, 26, 27, 29]

In Figure 1 [30] potential mechanisms for the effect of pain and fear on motor control are shown.

Functional rehabilitation

The new scientific knowledge on functional deficits is increasingly being transferred to clinical applications, where the aim is to reverse them with physical rehabilitation. As a result of the recognition of the behavioral (psychological) problems with LBP, psychological, behavioral and educational interventions are commonly combined with the physical rehabilitation for LBP also. The conceptual basis for this kind of rehabilitation lies in the bio-psycho-social model of illness.[31]

Confusingly, the terms multidisciplinary/bio-psycho-social/functional rehabilitation are widely used, although there are no precise definitions, not to mention a consensus, about what they actually mean in the area of low back rehabilitation. Guzman *et al*.[32] defined multidisciplinary biopsychosocial rehabilitation as the minimum of the physical dimension and one of the other dimensions (psychological or social or occupational) being included in the rehabilitation protocol. Multidisciplinary treatment is practiced in pain clinics or rehabilitation centers, which have rapidly increased in number over the last decades. The bio-psycho-social/multidisciplinary/functional model is also applied in outpatient rehabilitation. Regardless of the nomenclature, however, multidisciplinary/functional/bio-psycho-social rehabilitation regards disabling chronic pain as the result of multiple interrelating physical, psychological and social/occupational factors. In this review we use the term functional rehabilitation for treatments that combine at the minimum physical and behavioral (psychological) dimensions in low back rehabilitation.

TABLE I.—*Aims of functional rehabilitation.*

— Restoring the range of motion
— Restoring muscle co-ordination and movement control
— Improving muscle endurance
— Improving general condition
— Re-educating patients in the difference between normal physical loading and pain
— Reducing fears and avoidance behavior
— Tackling the psychological/social/occupational obstacles to return-to-work

As a fundamental, functional rehabilitation (Table I) includes systematic quantification of both the physical function and psychological factors, which drive the therapeutic process. The tests that measure range of motion, strength/endurance and coordination of the patient are periodically repeated during the rehabilitation treatment, allowing the scheduling of a correct therapeutic approach and giving the patient a feedback about the improvement of his/her physical capacity. In an intermediate phase of the program, the increase of patient's pain is often accompanied by the progressive reduction of the scores obtained by the functional quantitative evaluation.

The exercises used in the functional rehabilitation usually revolve around the treatment of the spine as a functional unit. Thus many programs for functional rehabilitation use rehabilitation equipment (isoinertial/isokinetic) by properly trained physiotherapists. However, some centers use regular fitness equipment or aerobics-type exercises. Furthermore, some relaxation and ergonomic exercises are typically proposed, and psychological support's provided along the treatment.

The occupational therapy may supervise the physical reconditioning too, but above all concentrates on functional tasks through the intensification and the simulation of work.

Furthermore, occupational therapists are involved, with the patient, in facing the obstacles to the financial, legal and occupational recovery; these are factors, which can heavily interfere with the return to work.

The psychological team works to maintain a positive therapeutic environment, facing the various

aspects of lumbar disability (Treatment Program of Multimodal Disability).

The inpatient approach

The inpatient functional rehabilitation has originally been developed in the USA (Texas) in the 80's and consists, after an outpatient preparatory period of 15-20 sessions, of an intensive inpatient treatment of 4 weeks, with daily treatment duration of 5-8 hours. Mayer and Gatchel have provided detailed reviews of this type of treatment.[33, 34] This approach is not applied in Italy and experiences in Europe are limited to Anglo-Saxon and Scandinavian countries, with a few exceptions in France. There are mixed results from studies conducted to date about this approach.[32]

The inpatient functional rehabilitation is very articulate and consists of an intensive multidisciplinary treatment, which includes a physical training and some ergonomic instructions (in small groups, sometimes individually), a psychological treatment of pain, back schools teaching and instructions regarding social and occupational matters. The key concepts include acceptance of pain, activity, self-responsibility, multidisciplinary treatment and functional quantitative evaluation.

The inpatient functional rehabilitation includes a therapeutic team-approach, which allows the physician to cope in a complete way with the patient's problems; the presence of physician, physiotherapist, occupational therapist, psychologist and trainer is fundamental. During the hospital stay, some theory lessons, recreational activities, psychological group therapies and socialization activities are also organized.

Understandably, due to the presence of the multidisciplinary team and relatively lengthy stay in the hospital, both direct and indirect costs of the intense inpatient rehabilitation are high and, subsequently, the inpatient approach is suitable for a carefully selected patient group only.

Outpatient approach

Outpatient care by definition refers to health care services that do not require a patient to receive overnight stay in a hospital. Outpatient functional rehabilitation is relatively inexpensive as compared to inpatient care not only due to the savings concerning hospital stay, but especially when the patient can continue working during the functional rehabilitation program. Outpatient rehabilitation programs typically include a patient visit 2 to 3 times a week, each visit lasting some 1 to 3 hours, the total program consisting of some 15 to 30 visits over a period of 5 to 15 weeks.

DBC is a functional outpatient rehabilitation program, originally developed in Finland, and now available in 22 countries across the world. The description of DBC program here is given as an example of an outpatient functional rehabilitation program. The approach has been tested in a randomized trial [35] and long-term follow-up of the outcomes has also been published.[36]

The key aims in DBC functional rehabilitation are to restore lumbar function and movement control on the other hand, and to influence the behavioral pattern of the patient in a way that he or she would be willing and capable of taking care of him/herself after the treatment. Individualized ergonomics guidance (*e.g.* workplace visits) and psychological support (counselling) can be included in the rehabilitation program according to the individual needs.

The contents and duration of the physical rehabilitation program are defined on the basis of the severity of pain and deconditioning, psychological profile, and social needs, which are assessed with validated questionnaires and measurements. A typical DBC program includes 2 visits a week, each taking one to one and half hours, over a period of 12 weeks. The questionnaires and assessments are essential not only in defining the needs, but they are also used in monitoring the progress and documenting the outcomes. Specially designed computer software is used for the documentation and management of patient information. It features functions to design treatment programs, evaluate test results, print reports and manage the data on a patient, group or clinic level.

The physical reconditioning program includes coordination, mobility and muscle endurance exercises. In addition, stretching and relaxation are included. Specially trained therapists guide the physical reconditioning program. The treatment is primarily based on exercises in iso-inertial rehabilitation devices; correct loading and range limiters ensure that exercises are performed in a painless range of motion and that they find their right target in the lumbar spine. Treatment includes controlled movements in lumbar/thoracic flex-

ion, extension, rotation and lateral flexion. Treatment is planned on the basis of initial endurance and mobility measurements and interviews, and records are kept of the progress. The treatment begins on low loads for the first weeks with the object of improving mobility and especially teaching proper co-ordination and control of the lumbar spine. The load is gradually increased so that only at the 6th to 8th week subjectively strenuous loading is first time applied, but within the pain tolerance of the individual patient. The load is further increased in a gradual and controlled manner until, at the end of the program, the patients are instructed to continue individual secondary prevention program once or twice a week with or without guidance depending on their individual needs. The inclusions of exercises, rate of progression in loading and ranges of motion are individualized based on the type (diagnosis) and severity of the back problem.

The skills of the therapists to target the loading accurately in the right place(s) especially at the early phase of the active treatment plays a crucial role in the success of the treatment program. The aim is to achieve segmental motion of the lumbar spine in a controlled manner. Very few individuals are able to produce the desired motion without the hip locking system in the devices and external guidance from the therapist. Later on, after the correct movements have been learned, the role of the therapist concerning the active treatment is primarily in guiding the progress in loading and movement ranges, and teaching a functional (home) exercise program, which the patient is advised to follow in order to maintain the results.

An elementary part of the treatment program is behavioral and cognitive support and motivation given by the therapists and other rehabilitation team. This is given using discussions concerning the benign nature and good prognosis of low back pain during treatment sessions, and written handouts, which describe the back problem in an understandable language, are distributed to the patient. In addition, the evaluation results especially concerning pain, disability and the objective measurements and their changes are used as a tool to convince the patient about progress. All this results as diminished fear of pain and increased self-efficacy beliefs.

Individualized occupational and ergonomics guidance and/or psychological support and counseling are combined to the rehabilitation program according to the individual needs in order to enhance return to work.

Results in Italy

The DBC outpatient rehabilitation has been available in Italy at the Milan center of the Fondazione Don Carlo Gnocchi for a few years: a preliminary study on the first treated patients has already been conducted, in order to evaluate the efficacy of such an approach in Italy.

The study included 55 consecutive patients (21 males, 34 females; mean age 51 years) with chronic low back pain or sciatica (mean duration 9.7 years). The treatment performed included exclusively DBC active rehabilitation, with 24 biweekly outpatient sessions; the treatment was planned according the initial evaluation scheduled by the DBC protocol. The conducted evaluations include pain intensity (VAS), disability scale, range of motion in flexion-extension, lateral rotation and flexion, fatigability in flexion-extension and a telephone follow-up at 1 year with a satisfaction scale for the result. The statistical analysis included: t-test, Mann-Whitney, ANOVA and Friedman (repeated measures), Bonferroni (multiple comparisons), Spearman, with significance 0.05.

We found an improvement of pain (females: from 67.7 to 50.1; males: from 51.9 to 43.6) and of disability (females: from 19.0 to 15.9; males: from 15.7 to 13.3). The international averages in DBC rehabilitation (n=6 986) show reductions in pain from 55 to 31.5 and disability from 14.4. to 9.8, compared to which the Italian results are modest. However, the patients are not directly comparable due to the older age (international average 42.5 year) and higher levels of baseline pain and disability in the Italian sample.

At 1-year follow-up, the satisfaction for the result (at least 3 point out of 5) has been: for the overall result of the treatment: males 78% and females 92%; for the reduction of pain: 72% and 74% respectively; for the RoM increase: 72% and 74%; for the capacity to withstand the efforts: 50% and 88%; for the capacity to perform daily life activities: 83% and 84%.

The patients included in the study were particularly demanding because of the high and long-lasting pain and of the notable degree of disability. The obtained result has been satisfactory and in line with the data coming from literature. The data about disability is interesting, because the main purpose in the rehabilitation is to reduce disability and not only to reduce pain, which however significantly improves. Then, results about satisfaction at 1 year are very significant, with 72% of males and 76% of females com-

pletely satisfied (5/5). The improvement obtained has therefore allowed the patients to resume the normal activities of daily life and to recondition their spine.

TABLE II.—*Assessment criteria for therapies.*

Efficacy	Does it work in clinical trials?
Safety	Does it have side effects?
Effectiveness	Does it work in the normal environment?
Cost-effectiveness	Is there efficient use of resources?

Evidence

Systematic reviews (SR) can help practitioners keep updated of the medical literature by summarizing large bodies of evidence and helping to explain differences among studies on the same question. As the review process is subject to bias, like any other type of research, a systematic review requires precise methods and clear reporting of the original information. This is a clear difference compared to the traditional narrative reviews, which are merely expert opinions, based on selected suitable studies. SRs are scientific investigations in themselves, with a set of original studies as their subjects. They synthesize the results of multiple primary investigations, preferably randomized controlled trials, by using strategies that limit bias and random error. These strategies include a comprehensive search of all potentially relevant articles and the use of precise, reproducible criteria in the selection of articles for review. Primary research designs and study methodology are evaluated, data are synthesized, and results are interpreted. Several SRs concerning the efficacy of treatments for low back disorders have been performed in recent years.

A recent SR analyzed 18 randomized controlled trials (RCTs) in 20 publications concerning work conditioning, work hardening and functional restoration (outpatient approach) for workers with back and neck pain. The paper ended up with the following conclusion: "Physical conditioning programs that include a cognitive-behavioural approach plus intensive physical training (specific to the job or not) that includes aerobic capacity, muscle strength and endurance, and coordination; are in some way work-related; and are given and supervised by a physiotherapist or a multidisciplinary team, seem to be effective in reducing the number of sick days for some workers with chronic back pain, when compared to usual care. However, there is no evidence of their efficacy for acute back pain".[37]

Another SR looking at 39 RCTs on exercise therapy (outpatient approach) for low back pain was summarized as follows: "The evidence summarised in this systematic review does not indicate that specific exercises are effective for the treatment of acute low back pain. Exercises may be helpful for chronic low back pain patients to increase return to normal daily activities and work".[38]

Systematic review on multidisciplinary bio-psychosocial rehabilitation for chronic low back pain (inpatient approach) concluded on the basis of 10 trials that "the reviewed trials provide evidence that intensive multidisciplinary bio-psycho-social rehabilitation with a functional restoration approach improves pain and function. Less intensive interventions did not show improvements in clinically relevant outcomes".[39]

There is also evidence supporting behavioral treatment for chronic low back pain based on 6 high quality RCTs: "Behavioural treatment seems to be an effective treatment for chronic low back pain patients, but it is still unknown what type of patients benefit most from what type of behavioural treatment".[40]

As a conclusion from the SR's, it may be stated that there is evidence supporting the efficacy of both outpatient and inpatient approach of functional rehabilitation. However, it is still unclear which patients benefit most of which type of treatment, and whether the clinical improvements in the inpatient multidisciplinary model are worth the high cost of these intensive treatments, as the evidence on return-to-work is inconclusive in the SR.

From scientific efficacy to cost-effectiveness

Besides scientific evidence, another element that should be considered while selecting the treatment/rehabilitation options for the patients is effectiveness (Table II). While scientific efficacy is preferably tested in RCTs, effectiveness studies assess the outcome of an intervention at the community level, *i.e.*, in real-life conditions. At this stage, both patients and health-care providers are much more variable than in controlled trials. The outcome criteria for effectiveness include safety, applicability and practicality of the treatment regimen, and the clinical outcomes in real-life.

Furthermore, analyses based on health economics,

such as cost-effectiveness and cost-benefit evaluations, relate clinical outcomes and monetary benefits to treatment costs. Economic evaluation is an option that can make the inevitable choices concerning which treatment option is to be chosen more rational and which allocation of resources more efficient. As indirect costs due to LBP are multifold compared to the direct costs, efficacious treatments have also potential for a good cost-benefit if they reduce absenteeism from work and increase the probability of return-to-work. Timing is also important. Early rehabilitation is crucial since the duration of absence from work is a strong determinant of disability and return-to-work, *i.e.*, the longer the delay for rehabilitation, the less likely is return-to-work. Rehabilitation costs are marginal as compared to the cost of disability. However, as the monetary resources for medical treatments are limited in our society, we must consider the cost element as well. Outpatient functional rehabilitation has a good potential for cost-benefit from the societal perspective, because it can be applied to a multifold number of patients due to the lower cost of treatment when compared to the inpatient approach.

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