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Subgrouping Patients With Low Back Pain: A Treatment-Based Approach to Classification

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Context: Low back pain (LBP) is a prevalent condition imposing a large socioeconomic burden. Despite intensive research aimed at the efficacy of various therapies for patients with LBP, most evidence has failed to identify a superior treatment approach. One proposed solution to this dilemma is to identify subgroups of patients with LBP and match them with targeted therapies. Among the subgrouping approaches, the system of treatment-based classification (TBC) is promoted as a means of increasing the effectiveness of conservative interventions for patients with LBP.

Evidence acquisition: MEDLINE and PubMed databases were searched from 1985 through 2010, along with the references of selected articles.

Results: TBC uses a standardized approach to categorize patients into 1 of 4 subgroups: spinal manipulation, stabilization exercise, end-range loading exercise, and traction. Although the TBC subgroups are in various stages of development, recent research lends support to the effectiveness of this approach.

Conclusions: While additional research is required to better elucidate this method, the TBC approach enhances clinical decision making, as evidenced by the improved clinical outcomes experienced by patients with LBP.

Keywords: low back pain, classification, decision making, exercise, manual therapy

Low back pain (LBP) is a common and costly complaint, with the point prevalence ranging from 12% to 33%, the 1-year prevalence from 22% to 65%, and the lifetime prevalence from 11% to 84%.[113] Estimates of the economic costs in different countries vary greatly but must be considered a substantial burden on society.[31] In the United Kingdom each year, the National Health Service physiotherapy and hospital costs directly related to LBP are £150.6 million and £512 million, respectively.[94] Thirteen percent of all unemployed people reported that LBP was the reason that they were not working.[36] In the United States, $26 billion per year in health care expenses were directly attributable to treating LBP. Individuals with LBP incur health care expenditures about 60% higher than those without back pain.[83] In Australia, the estimated direct and indirect cost of LBP in 2001 was A$9.17 billion.[114]

Chronic LBP is a disabling condition and is particularly costly to individuals and the community.[30] In the majority of those presenting with acute LBP, the cause of pain is thought to be nonspecific and possibly caused by a variety of etiologies.[74] Serious underlying conditions are rare.[72] While risk factors for LBP are multidimensional, with physical attributes, socioeconomic status, general medical health, psychological status, and environmental factors all contributing.[99]

Clinical experience often leads health care providers to believe that manual, exercise, and traction therapies are effective for patients with LBP. Unfortunately, evidence for the effectiveness of these therapies remains suboptimal. While studies have described benefit from a broad range of physical and pharmacologic interventions when compared with natural history or placebo therapies, these benefits have small effect sizes, with only small differences in outcome observed when alternative therapies are compared.[24,101,111,112] This understanding can lead to the mistaken impression among clinicians and policy makers that there are no effective or efficient treatment options for patients with LBP. The objective of this review is to discuss the elements of current research that may partly explain why this is so and to summarize and update one approach to LBP classification.

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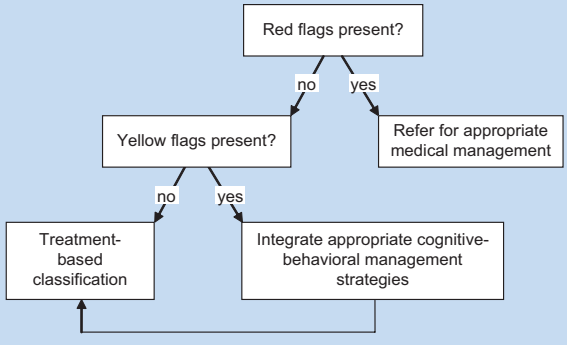

Figure 1. Stepwise decision-making process for patients with low back pain assessed using treatment-based classification.

Figure 2. Supine lumbopelvic spinal manipulation technique.

SUBGROUPING STRATEGIES AND TREATMENT-BASED CLASSIFICATION

The apparent lack of treatment effect mentioned above may be partly due to the tendency of researchers to treat nonspecific LBP as one homogenous condition, rather than a heterogeneous collection of differing conditions that may preferentially respond to different treatments.[58] Many different methods of subgrouping patients have been developed over the past century. Traditional subgrouping strategies are based on pathoanatomy and have failed to establish relationships between pathology and symptoms.[1,37] An alternative approach is to classify patients into clinically relevant subgroups.[15,63] One method of classification involves the identification of unique patient attributes that allow patients to be matched to the most appropriate therapeutic approach.[35,89,92,115] This review focuses on one of these approaches: the system of treatment-based classification (TBC), as first described by Delitto et al.[35,48,61]

The TBC approach involves a stepwise process of clinical decision making (Figure 1). Patients with LBP are first screened for signs of serious pathology and the presence of biopsychosocial "yellow flags." Next, information from their history and physical examination is used to match their clinical presentation to the most appropriate therapy, by placing them into a treatment subgroup named for the primary therapy employed: spinal manipulation, stabilization exercise, end-range loading exercise, and traction.

TREATMENT SUBGROUPS

Spinal Manipulation Subgroup

Spinal manipulation has been used for centuries and remains one of the most common treatments for LBP.[43] As spinal manipulation can result in rapid clinical benefit in some individuals[23,44] and can be applied very quickly with little to no equipment, its use in athletes is especially appealing. The safety of spinal manipulation has generated a great deal of discussion and inquiry. Benign, self-limiting adverse events such as short-term soreness following spinal manipulation are common[8,21,81]; however, serious adverse events are rare.[5,57] Therefore, spinal manipulation is considered a safe therapeutic option for the patient with LBP.[100]

The mechanism by which spinal manipulation exerts its clinical effects has also been the subject of much debate and investigation.[12,14,39] Traditional theory has emphasized the restoration of joint motion and/or correction of biomechanical misalignment.[56,85,90] More recent evidence suggests a primarily neurophysiologic effect on pain perception and muscle function.[12,13,77]

Evidence for the efficacy of spinal manipulation for LBP has been mixed. While multiple trials and systematic reviews support its efficacy,[18,19,112] others do not.[6,40] The conflicting results and small effect sizes found in many trials may stem from the treatment of heterogeneous back pain as though it arises from a common cause.[34] In other words, while spinal manipulation may be an effective treatment option for some patients with LBP, not all patients will benefit from this therapy.

Initially, the spinal manipulation subgroup was identified by proponents of TBC using a traditional biomechanical paradigm in which manipulation was indicated in the presence of lumbosacral asymmetries and/or "capsular patterns" of facet joint motion restriction.[35] To more objectively define this subgroup, Flynn et al[44] derived a clinical prediction rule (CPR) that identifies people likely to experience clinical success from spinal manipulation. Two sessions of lumbopelvic manipulation (Figure 2) were applied to 71 consecutive patients with nonradicular low back pain. Clinical success was defined as a 50% improvement in Oswestry Disability Index score, which reflects a significant improvement in clinical status.[50] Five factors from the history and physical examination predicted clinical success at 1 week (Table 1). Overall, just under half the patients experienced clinical success with spinal manipulation.

Table 1. Treatment-based classification subgroups with identification criteria and treatment approaches for patients with low back pain.[a]

Subgroup Criteria	Treatment Approach
Manipulation subgroup	
No symptoms distal to knee Duration of symptoms < 16 days Lumbar hypomobility FABQW < 19 Hip internal rotation ROM > 35°	Manipulation techniques for the lumbopelvic region Active lumbar ROM exercises
Stabilization subgroup	
Age (< 40 years) Average SLR ROM (> 91°) Aberrant movement present FABQW < 19 Positive prone instability test	Exercises to strengthen large spinal muscles (eg, erector spinae, oblique abdominals) Exercises to promote contraction of deep spinal muscles (eg, lumbar multifidus, transversus abdominis)
End-range loading exercise subgroup	
Extension	
Symptoms distal to the buttock Symptoms centralize with lumbar extension Symptoms peripheralize with lumbar flexion Directional preference for extension	End-range extension exercises Mobilization to promote extension Avoidance of flexion activities
Flexion	
Older age (> 50 years) Directional preference for flexion Imaging evidence of lumbar spine stenosis	End-range flexion exercises Mobilization or manipulation of the spine and/or lower extremities Exercise to address impairments of strength or flexibility Body weight–supported ambulation
Traction subgroup	
Symptoms extend distal to the buttock(s) Signs of nerve root compression are present Peripheralization with extension movement OR positive crossed SLR test is present	Prone mechanical traction Extension specific exercise activities

[a]FABQW, Fear-Avoidance Beliefs Questionnaire–Work subscale; ROM, range of motion; SLR, straight-leg raise. Adapted with permission from Hebert et al.[61]

However, the probability of experiencing clinical success increased to 95% when patients met at least 4 of 5 criteria from the history and physical examination.

Subsequent work has supported the validity of the CPR. A multicenter randomized controlled trial[23] found that patients who were positive on the CPR and received spinal manipulation and stabilization exercise were more likely to experience clinical success than patients who were CPR positive and received stabilization exercise only or were CPR negative and received stabilization exercise with or without spinal manipulation. The clinical benefit of receiving matched treatment (ie, spinal manipulation and CPR positive) persisted for 6 months. This suggests that the CPR criteria can identify those individuals with LBP who benefit from spinal manipulation, not just those patients who have a favorable prognostic course. Therefore, the utilization of this CPR appears to enhance clinical decision making for patients with LBP.

Subsequent research has examined the generalizability of the CPR to the use of other manual therapy approaches. These studies suggest that this subgroup of patients respond equally well to other manipulative thrust techniques (Figure 3)[27,106] but not to nonthrust mobilization techniques.[27,59]

All together, these studies suggest that (1) the identification of the proper patient subgroup is more important to a successful outcome than choosing the right manipulative technique and (2) the application of spinal manipulation based solely on a paradigm of biomechanical faults and/or spinal misalignments is inappropriate.

Figure 3. Side-lying lumbopelvic spinal manipulation technique.

Stabilization Subgroup

Spinal instability is a theorized mechanism of LBP used to justify therapies from exercise to surgical fusion.[53,93,103] Recent research into lumbar spine stability has emphasized the morphology and function of the trunk musculature. In asymptomatic individuals, some trunk muscles (eg, transversus abdominis, lumbar multifidus) contract in anticipation of extremity movement.[3,70,86] This feedforward behavior is disturbed in individuals with LBP, with delayed transversus abdominis and lumbar multifidus muscle activation.[69,71,73,84] Additionally, fatty infiltration[76,91] and atrophy[7,33,116] of the lumbar multifidus are associated with LBP.

Stabilization exercise can normalize the timing of trunk muscle activation.[108,109] Moreover, improved trunk muscle function following a stabilization exercise program is associated with enhanced clinical outcomes.[42] It is not known if stabilization exercises can influence the distribution of intramuscular fat within the paraspinal musculature; however, evidence suggests that such programs can reverse lumbar multifidus atrophy among athletic and nonathletic populations.[66-68]

Research examining the efficacy of stabilization exercise programs for patients with LBP have provided conflicting results.[22,29,41,55,65,79] Additionally, there is much debate on the most effective method of stabilization exercise. One method stresses the importance of retraining specific muscles, such as the transversus abdominis and lumbar multifidus,[98] while other methods emphasize the general restoration of the strength and endurance of trunk muscles.[87]

Clinical trials comparing the efficacy of these approaches have reported conflicting results supporting the motor control[41,45] and general stabilization approaches.[79] Additional research is needed to further elucidate the optimal approach to lumbar stabilization exercise. Despite this, stabilization exercise programs are effective for some patients,[55,65,79,95] and the observed treatment effect may be more pronounced with consideration of the proper subgroup of individuals with LBP.[64]

Hicks and colleagues[64] derived a CPR that sought to identify those with LBP most likely to achieve clinical success with an 8-week stabilization exercise program. Four variables relating to clinical outcome were identified (Tables 1 and 2). When 3 variables were present, the probability of achieving clinical success improved from 33% (among unclassified patients) to 67%.

These predictive criteria have yet to undergo validation through the rigors of a randomized trial. However, the construct validity of these variables has been supported through their relationship with lumbar segmental kinematics (aberrant segmental structural integrity, segmental stiffness, and altered neuromuscular control during lumbar spine movement)[107] and lower levels of lumbar multifidus activation.[62]

End-Range Loading Exercise Subgroup

Popularized by McKenzie's system of mechanical diagnosis and therapy,[89] end-range loading exercises are often prescribed for patients with radicular low back pain whose symptoms benefit from end-range postures or movements (eg, lumbar flexion, extension, lateral translation, or combined movements). The prescribed direction of treatment depends on a patient's response, especially the presence or absence of directional preference or centralization phenomena.

Directional preference describes the clinical situation where movement in one direction improves pain or range of motion and where movement in the opposite direction may cause symptoms to worsen.[75] Patients can have a directional preference for flexion, extension, or lateral translation, although extension is the most common.[82] While end-range loading exercises may be prescribed in the direction of a patient's directional preference, advocates of TBC have emphasized the related concept of centralization (Table 1).

Centralization describes the clinical situation where a movement or position results in the migration of symptoms from a more distal/lateral location in the buttocks and/or lower extremity to a more proximal location, closer to the midline of the spine.[2] Advocates of TBC have expanded this definition to include the abolishment of distal pain and/or paresthesias.[48] Therefore, patients who demonstrate centralization would be considered to have a directional preference, but not all patients that have a directional preference experience centralization.[48,119] As with directional preference, treatment recommendations can be dictated by the presence of centralization. For example, patients who centralize with extension may be advised to perform the prone press-up exercise (Figure 4) frequently throughout the day. Additionally, this treatment is often accompanied by manual spinal mobilization into lumbosacral extension (Figure 5) and temporary avoidance of flexion activities (eg, improper bending, slumped sitting) (Table 1).

Centralization is of prognostic importance for patients with LBP.[10,54,105,117,118] Moreover, centralization appears to identify the subgroup of patients that require end-range loading exercises. Browder et al[20] found that patients with LBP whose symptoms centralized with lumbar extension experienced better clinical outcomes when prescribed extension end-range loading exercises and mobilizations as compared with patients

Figure 4. Example of an end-range loading exercise into extension: the prone press-up.

Figure 5. Posterior to anterior mobilization to promote lumbosacral extension.

randomized to receive lumbar stabilization exercises. A recent systematic review of the centralization phenomenon concluded with the recommendation that centralization be routinely monitored and used to guide treatment strategies in patients with spinal pain.[2]

Additional evidence suggests that the directional preference and centralization phenomena may identify the presence of spinal pathology.[9,38,80,122] Beattie et al[9] investigated the effect of extension-based end-range loading exercises and mobilizations on L5-S1 intervertebral disc hydration among a subgroup of patients with LBP who demonstrated a directional preference for extension. They reported that participants who experienced immediate reductions in LBP following extension exercise (ie, exercise responders) demonstrated increased water diffusion in the L5-S1 intervertebral disc, while nonresponders demonstrated decreased diffusion.

While extension responders form the largest proportion of the end-range loading exercise subgroup, some patients appear to benefit from flexion end-range loading exercises. These patients are often assumed to have spinal stenosis[28,46] and improve when flexion exercises are incorporated into a multimodal treatment program.[121]

The possible associations between centralization, direction preference, and spinal pathoanatomy are an emerging area of study; however, additional research is required to understand these relationships. Nonetheless, it appears that centralization and directional preference are important factors in the evaluation and management of this subgroup of patients with LBP. Current understanding presumes that centralization and/or a directional preference for extension may help to identify patients experiencing discogenic pain, while centralization and/or a directional preference for flexion is most likely associated with spinal stenosis.

Traction

The use of mechanical spinal traction for LBP and other disorders of the lumbar spine has a long history in medicine and continues to be used by clinicians today.[104] Yet, clinical trials examining heterogenous populations of individuals with LBP[11,16,110,120] have failed to demonstrate the efficacy of mechanical traction, and current treatment guidelines do not support its use.[25,102] Most clinicians who recommend traction do so using criteria to identify a more selective group of patients with LBP. Traditionally, these criteria have focused on the presence of sciatica or signs of nerve root compression.[60]

To better identify these patients, a recent clinical trial examined the characteristics of patients with LBP and sciatica who experienced a favorable clinical response with mechanical traction and extension end-range loading exercises.[51] Radicular leg pain and signs of lumbar nerve root compression did not adequately identify this subgroup of patients. Two additional factors were related to clinical outcome: peripheralization with extension movement and a positive crossed straight-leg raise test (Table 1). Peripheralization occurs when a movement or posture causes distal migration of symptoms (eg, lumbar extension causes posterior thigh pain to extend to the dorsal aspect of the foot).[61] The crossed straight-leg raise test is deemed positive when the patient's familiar lower extremity symptoms are reproduced upon passive flexion of the contralateral leg while the knee is fully extended.[78] When either factor is present along with radicular leg pain and signs of nerve root compression, patients are more likely to benefit from traction therapy and end-range loading exercises into lumbar extension when compared to extension exercises alone. Ongoing research may well provide additional clarification to these preliminary findings.[52]

Clinicians use a variety of lumbar traction approaches (or spinal decompression[32] approaches). However, no generally accepted traction protocol is available.[26] When identifying a traction protocol for the individual patient, clinicians need to consider various factors, including patient positioning (eg, prone or supine), maximal force and force progression, duration of force application, and the inclusion of additional therapies (eg, end-range loading exercise). The protocol used

Table 2. Special examination procedures identifying the stabilization exercise subgroup.

Criterion: Definition of Positive
Aberrant movements
The presence of one or more of the following during standing trunk flexion testing: *Instability catch:* Movement other than in the sagittal plane (eg, lumbar spine rotation or lateral flexion) or a sudden acceleration or deceleration of trunk movement *Gower sign:* The patient uses his or her hands to push upon the thighs or other surface to assist with the attainment of an erect posture from a flexed posture. *Reversal of lumbopelvic rhythm:* The patient returns to an erect posture from a flexed position by flexing the knees and translating the pelvis anteriorly. *Painful arc of motion:* Increased discomfort is experienced during lumbar spine flexion or return from flexion that occurs at a specific point or range and is not present before or after this point.
Prone instability test
The patient lies prone with his or her trunk on the table and feet on the floor. The clinician manually applies posterior-to-anterior pressure to each lumbar spinous process that results in pain. The patient is then asked to lift his or her feet from the floor, and the process is repeated with the pain relieved at the respective lumbar segment.

to identify the traction subgroup within TBC involves the static application of high-force traction (between 40% and 60% of body weight) with the patient in the prone position.[51]

LIMITATIONS AND IMPLEMENTATION OF THE CURRENT MODEL

The subgroups defining the TBC approach were identified through a combination of clinical knowledge and research activity, including the development of CPRs (also known as *clinical decision rules*). These tools are designed to assist with clinical decision making by statistically combining historical, clinical, laboratory, and/or imaging findings to improve diagnostic accuracy, prognostic understanding, or prediction of therapeutic response.[88,96] Within the realm of rehabilitation, CPRs are most commonly used to predict a patient's treatment response. Specifically, CPRs can be used to identify discrete subgroups of patients who are likely to respond to a particular therapy that would otherwise fall into a broad, homogenous diagnostic category such as LBP.[47]

The development of CPRs occurs in 3 stages: derivation, validation, and impact analysis.[88] CPR derivation studies seek to identify variables with predictive power that may aid clinicians when making decisions about their patients. Validation studies examine the predictive criteria for evidence of reproducible accuracy, while impact analyses investigate the ability of a CPR to change clinician behavior, improve clinical outcomes, and/or cost effectiveness. While it is appropriate for clinicians to use data from derivation studies to inform clinical decision making, CPRs must undergo the rigors of validation prior to confident implementation.[88]

As we have discussed, the TBC subgroups are each in various stages of development, with corresponding differences in their levels of evidence. This fact requires our attention, as lower levels of evidence are more subject to the dangers of bias and confounding.[97] Traditional wisdom tells us that strong evidence of clinical and cost-effectiveness should inform clinical practice. While only one of the treatment subgroups (manipulation) has been validated, the TBC approach as a whole has demonstrated some degree of clinical effectiveness. Fritz et al[49] performed a clinical trial comparing the effectiveness of TBC to therapy based on the Agency for Health Policy and Research guidelines for patients with acute LBP. Classified patients experienced greater short-term improvements in LBP-related disability and return-to-work status. Similarly, Brennan and colleagues[17] examined the clinical outcomes of patients with LBP who received treatment that was either matched or unmatched according to the TBC subgroups. Patients receiving matched treatment experienced greater improvements in short- and long-term LBP-related disability. Ongoing research efforts should help to inform the cost implications of TBC-informed clinical decision making.[4]

CONCLUSIONS

Subgrouping patients with LBP using the TBC criteria allows for improved identification of those who are most likely to experience clinical success with spinal manipulation, stabilization exercise, end-range loading exercise, and traction therapies. Although each of the 4 TBC subgroups are in various stages of development and validation, current evidence suggests that TBC-informed clinical decision making improves the effectiveness of care provided to patients with LBP. Therefore, TBC can be recommended as an approach for matching patients to the most appropriate therapeutic intervention.

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