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Spinal Manipulation in Physical Therapist Professional Degree Education: A Model for Teaching and Integration Into Clinical Practice

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Spinal manipulation for low back complaints is an intervention supported by randomized clinical trials and its use recommended by clinical practice guidelines. Physical therapists in this country and internationally have used thrust spinal manipulation at much lower-than-expected rates, despite evidence supporting its efficacy for the treatment of acute low back pain (LBP). The purpose of this clinical commentary is to describe a physical therapist professional degree curriculum in thrust spinal manipulation and outline a method of monitoring ongoing student performance during the clinical education experience. Increased emphasis on evidence-based decision making and on the psychomotor skills of thrust spinal manipulation was introduced into a physical therapist professional degree curriculum. As part of ongoing student performance monitoring, physical therapy students on their first full-time (8-week) clinical education experience, collected practice pattern and outcome data on individuals with low back complaints. Eight of 18 first-year students were in outpatient musculoskeletal clinical settings and managed 61 individuals with low back complaints. Patients were seen for an average (±SD) of 6.2 ± 4.0 visits. Upon initial visit the student therapists employed spinal manipulation at a rate of 36.2% and spinal mobilization at 58.6%. At the final visit, utilization of manipulation and mobilization decreased (13% and 37.8%, respectively), while the utilization of exercise interventions increased, with 75% of patients receiving some form of lumbar stabilization training. Physical therapist students used thrust spinal manipulation at rates that are more consistent with clinical practice guidelines and substantially higher then previously reported by practicing physical therapists. Education within an evidence-based framework is thought to contribute to practice behaviors and outcomes that are more consistent with best practice guidelines. *J Orthop Sports Phys Ther 2006;36(8):577-587.* doi:10.2519/jospt.2006.2159

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Spinal manipulation (thrust and nonthrust) is an intervention used by physical therapists in the treatment of individuals with LBP, for which there is evidence to support its use.[37,40] Several randomized trials have found spinal manipulation to be more effective than placebo or other interventions.[15,18,31,43] Based on the evidence supporting its use, clinical practice guidelines in the United States,[6] New Zealand,[30] United Kingdom,[40] and several other nations recommend manipulation for patients with acute LBP who do not demonstrate neurological deficits. Recently, a large-scale randomized controlled trial demonstrated that spinal manipulation or spinal manipulation coupled with exercise improved back function at 3 months and 1 year.[5] Furthermore, manipulation alone was more cost effective than manipulation followed by exercise.[4] The use of the term *thrust spinal manipulation* in this paper refers to a high-velocity low-amplitude spinal manipulation procedure, and is to be distinguished from other manual therapy procedures that do not include a thrust component.

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CLINICAL COMMENTARY

Despite evidence that suggests manipulation is an effective and potentially cost-saving intervention for patients with LBP, it seems to be underutilized by physical therapists, when compared to utilization rates of other interventions that have little to no evidence to support their use. Jette and Delitto[26] reviewed 1279 episodes of care for patients with LBP receiving physical therapy. The authors reported that manipulation was utilized at a rate of 3.7% during the initial stage of care.[26] Interventions with little supporting evidence were utilized at much higher rates during the initial stage. These interventions included mobilization (27.2%), heat (79.1%), electrical stimulation (39.6%), and flexibility exercises (75.1%).[26] Additional studies of practice patterns both within and outside of the United States also report low rates of utilization of spinal manipulation by physical therapists for patients with LBP.[22,23,25,27] Although the optimal rate for use of manipulation is not known, it is reasonable to expect that the utilization of manipulation would exceed that of interventions without supporting evidence, if therapists are choosing to practice in an evidence-based manner. Previous studies that have sought to identify subgroups of patients with LBP have reported that 35% to 48% of patients referred to physical therapy are likely to respond to spinal manipulation,[9,19,20] suggesting that manipulation is being underutilized in clinical practice.

One explanation for the low utilization of manipulation relative to other interventions with little supporting evidence may be a lack of understanding of what constitutes current best evidence and the role of evidence in clinical decision making. Li and Bombardier[28] surveyed 569 physical therapists in Canada regarding their treatment beliefs and recommendations for patients with LBP. Overall, 30% of the therapists surveyed reported that they believed spinal manipulation to be an effective treatment in the management of most patients with LBP. The percentage of respondents expressing a belief in the effectiveness of several interventions lacking evidence for effectiveness was much higher, including ice (82%), heat (66%), electrical stimulation (53%), and mechanical traction (36%),[28] indicating a lack of knowledge of the current evidence.

Connolly et al[11] surveyed 115 physical therapists 12 months after graduating from their professional training regarding their attitudes towards research and evidence-based practice. Several questions were asked about what should form the basis of clinical practice. Agreement with the statement that clinical practice should be based on published evidence was no different than agreement with the statement that practice should be based on what has been used over the years and what experts recommend, indicating a lack of understanding of the role of evidence in clinical decision making.[11]

Changing attitudes towards the use of evidence-based interventions and practice guidelines have been the subject of numerous studies in the medical literature.[14] The general consensus of these studies indicate that traditional continuing education based on lectures or written dissemination of information to practicing clinicians is ineffective for changing behaviors.[13,14,34] However, interactive continuing medical education sessions that provide an opportunity to practice skills can effect change in professional practice and, on occasion, healthcare outcomes.[13] Turner and Whitfield[36] surveyed physical therapists in the United Kingdom and Australia to ascertain the basis on which therapists made decisions to use an intervention. The most common reasons given by respondents were that they were taught the intervention in their initial training and had used the intervention in their prior experience.[36] The optimal time to influence clinical decision making may, therefore, be during the physical therapist professional degree program. Because of the influence first professional education has on future clinical decision making, the Manipulation Education Manual for Physical Therapists Professional Degree Programs (MEM) was developed to support the ongoing efforts in physical therapist education programs to provide appropriate, evidence-based instruction in thrust manipulation.[2] The remainder of this commentary will briefly describe a physical therapist professional degree curriculum in thrust spinal manipulation and a method of outcome monitoring to evaluate student performance during their clinical experiences.

FIRST PROFESSIONAL DEGREE CURRICULUM

Musculoskeletal Component of the Curriculum

The US Army-Baylor University Graduate Program in Physical Therapy uses a regionally based musculoskeletal curriculum that begins with the lower extremity course in the first semester and spine and upper extremity courses in the second and third semesters. In a regional-based curriculum, all anatomy, physical therapy procedures, and physical therapy management course materials related to a particular region (ie, hip region, knee region) are presented concomitantly. Throughout all components of the curriculum, a specific emphasis has been placed on the knowledge, skills, and attributes necessary to be a lifelong learner and an evidence-based practitioner. In particular, literature searching and critical appraisal skills in the context of the related body region are stressed. In the spine region, the course focuses on low back disorders, emphasizing those examination and therapeutic procedures that have moderate to good evidence supporting their use. Due to the evidence available at the time

supporting the use of manipulation for acute LBP,[6,30,40] clinical examination, decision-making skills, and the development of psychomotor skills related to thrust spinal manipulation intervention are emphasized.

Laboratory sessions are conducted in an interactive and problem-solving fashion. A student is randomly assigned to demonstrate the physical examination process to the group. The other students provide performance critique and feedback. The focus then shifts to the search and analysis of the current best evidence for managing LBP. The starting point is the various clinical practice guidelines, with concurrent student searches for clinical trials published since the release of the practice guidelines. Evidence for clinical decision making, including the integration of clinical prediction rules, is also stressed. The inadequacy of the pathoanatomical model is highlighted and emphasis is placed on classifying and subgrouping patients based on a broader biopsychosocial model of LBP.[38,39]

THRUST SPINAL MANIPULATION: TEACHING A PSYCHOMOTOR SKILL

Step 1. Clinical Reasoning

The first step in teaching thrust spinal manipulation as a clinical skill is teaching the student to identify patients with LBP who are most likely to respond to the intervention. Though many theoretical approaches for identifying patients likely to benefit from thrust spinal manipulation have been proposed,[12,29] there is little evidence to support any single approach. These approaches frequently incorporate complex diagnostic schemes based on pathoanatomical and biomechanical theories that utilize various examination procedures to identify a pathological motion segment or a biomechanical dysfunction, towards which a manipulation technique is then directed. However, relevant pathoanatomical mechanisms can be identified in only a small percentage of patients with LBP,[1] and many of the tests proposed to identify biomechanical dysfunction are of questionable reliability and validity.[16,17,35] Furthermore, complex biomechanical theories often leave the student (and clinician) with the notion that there are a nearly infinite number of clusters of signs and symptoms a patient may demonstrate, with each pattern of findings being pathognomonic of a particular manipulative technique.

Numerous thrust spinal manipulation techniques have been described. One technique that has been specifically examined in the literature is described as a lumbopelvic region manipulation proposed to affect primarily the sacroiliac area (Appendix A). This technique has been explicitly studied and found to be more effective than alternative exercise interventions.[10,15,18] Furthermore, we have subsequently published a clinical prediction rule that describes the clinical characteristics of patients with LBP who are likely to respond to this particular technique[19] and the rule has been validated in a multicentered clinical trial.[10] Because of the supporting evidence, we believe that this technique should be taught in an evidence-based curriculum. Students are taught to identify patients likely to benefit from thrust spinal manipulation based on the clinical prediction rule, instead of relying on theories and tests with dubious validity.

Step 2. Skill Acquisition

Most manipulation techniques have not been studied in isolation in the way that the lumbopelvic region technique has been and, therefore, the faculty has selected a basic or core set of additional procedures that are instructed to the students.[42] The techniques are outlined in Appendix A. With the exception of the lumbopelvic region manipulation technique, there is a lack of evidence or prediction rules to help with identifying which patients are most appropriate for each technique. Therefore, an impairment-based model is employed and terminology consistent with the movement restriction is employed. For example, if a patient's primary impairment is judged to be flexion as evidenced by movement patterns, then a manipulation into the flexion range of motion is selected. An expectation is that the students demonstrate proficiency early on in the course with these techniques. Several teaching methods are used to increase proficiency. In particular, video augmented instruction is a hallmark of the course. Each of the techniques is available on the electronic text[42] and students frequently comment on how this improves their visualization of how to accomplish the motor skill of the patient setup procedure. In addition, laboratory instruction breaks the skills into 2 components, the setup/localization and the graded oscillations that lead up to high-velocity thrust manipulation. Students repeatedly go through the setup/localization with partner and instructor feedback. Subsequently, the high-velocity thrust component is practiced in a "midrange" position to develop the velocity and the control elements of the skill in a position of relative comfort for the partner.

Step 3. Determination of Outcomes

A central tenet of evidence-based practice is to monitor the outcomes of one's own performance.[33] Students are therefore taught principles related to the determination of the clinical outcomes of their

treatments. Instruction in principles important to the selection and interpretation of outcome measures is primarily provided in the students' research and evidence-based practice course work, but is reinforced in the musculoskeletal curriculum. Key principles taught in the research curriculum include test-retest reliability, construct validity, responsiveness, minimum clinically important change, and minimum detectable change of outcome measures. Students are also taught the importance of focusing on patient-centered measures, such as disability scales, instead of impairment outcomes such as range of motion for monitoring outcomes. Application of these key concepts for patients with LBP is provided in the musculoskeletal curriculum. The modified Oswestry Disability Index (ODI)[21] is a disability scale for patients with LBP with well-established psychometric properties[32] and is, therefore, used as the outcome score in all patient examples discussed in class. Students are taught that the minimum clinically important change for the ODI is about 6 points,[21] and ODI improvements of a magnitude of at least 50% represent successful clinical outcomes.[19]

Step 4. Skill Assessment and Practical Examination

During subsequent lab sessions, students are randomly drawn to explain the rationale (based on current best evidence or targeted impairments) for a previously introduced spinal manipulation procedure. They are then required to demonstrate the technique on a laboratory partner. The remaining students and the faculty member analyze the rationale and the application of the procedure, then provide critical feedback. Occasionally, the faculty members will role-play as a clinical instructor and challenge the student on their rationale for treatment selection. The final practical examination includes a patient scenario where a fellow student acts out the patient part. All students are tested on a minimum of 3 thrust spinal manipulation procedures. The criteria for successful and safe application of the procedures are clearly stated and failure to meet these criteria results in student remediation. Failure to successfully perform the procedures after remediation results in course failure.

Clinical Education Experience

Throughout the course, published data on lower-than-expected utilization rates of manipulation in patients with LBP by physical therapists is presented and discussed with the students. Students are made aware that in many instances they will have more current instruction in thrust spinal manipulation than their clinical instructors and strategies to overcome resistance to manipulation by clinical instructors are provided to the students. Additionally, students generated ideas on the best ways to encourage implementation of evidence-based interventions at their first clinical education site.

In an effort to foster the students' practice of monitoring their own performance, we require students during their clinical experience to assess a minimum number of key examination findings and outcome variables in every patient with LBP that they manage. The faculty members for the spine region determined that the following variables would comprise minimum data collection: location of symptoms, numeric pain rating scale, ODI, and lumbar flexion and straight leg raise range of motion measured with a gravity inclinometer.[41] The minimum data collection form with instructions and other data fields is provided in Appendix B. Students collected these data for all their patients with LBP at the initial, week 2, and final visits, and entered them into a formatted spreadsheet they received prior to their clinical experience. In addition, information regarding interventions rendered, total visits, and type and number of complications were also entered. This monitoring of student clinical behaviors was approved by the joint Brooke Army Medical Center and Wilford Hall Medical Center Institutional Review Board. At the end of the affiliation students submitted their practice pattern and outcome data to the Research Director (R.S.W.) for data compilation and analysis.

At the conclusion of the clinical experience, the faculty and students conduct a postclinical discussion on strengths and weaknesses of their clinical education experience. During this time all students were verbally queried in a group setting about their satisfaction with their management of patients with LBP. The spine region instructors then presented the results of the groups' compiled data collection, along with the types of interventions employed, and compared these data to previously published management guidelines and practice patterns. Students were then asked if their initial impressions regarding LBP management were altered after observing their outcome data.

INITIAL APPLICATION OF THE EDUCATIONAL MODEL

Students

Included students were in their first year of a physical therapist first professional degree program (MPT program at the time, currently a DPT) at the US Army-Baylor University Graduate Program in Physical Therapy. All students contributing data to this report had successfully completed 2 semesters of coursework to include courses in evidence-based prac-

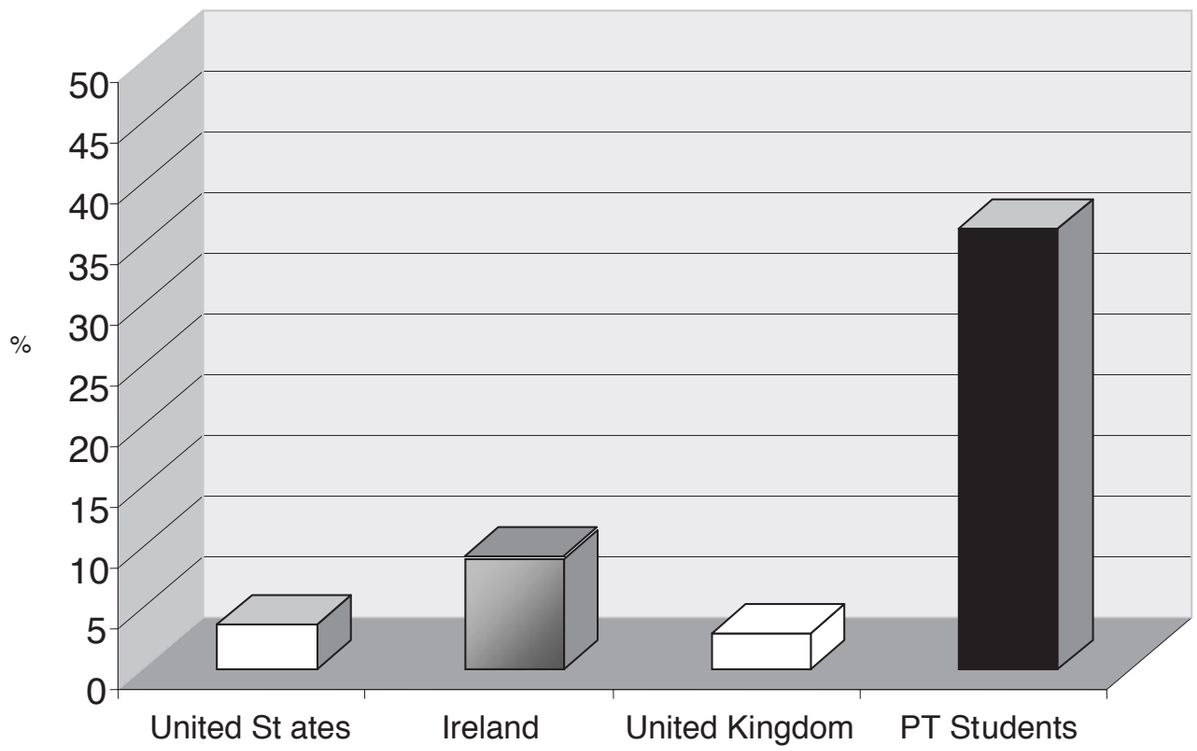

FIGURE 1. Spinal manipulation utilization rates by physical therapists comparing the rates in the United States (Jette and Delitto[26]), Ireland (Gracey[23]), United Kingdom (Frost et al[22]), and physical therapist students.

tice, introduction to joint mobilization/manipulation, and a 4-credit course on the evaluation and management of spinal disorders.

Patient Care Outcomes

Eight of 18 physical therapy students were in outpatient musculoskeletal clinical settings that managed individuals with LBP. Minimum data collection forms were submitted on 61 patients (38 male, 24 female). The patients were on average 34 (SD, ±16) years old and reported a mean duration of current low back symptoms of 112 days (median, 42.5 days). Additionally, 50% had buttock or leg symptoms, and 65% reported a prior episode of LBP. Patients were seen in physical therapy for an average of 6.2 (SD, ±4.0) visits. Figure 1 compares the thrust spinal manipulation utilization rates between those previously reported in the literature and the physical therapy students. A higher percentage of utilization was seen in the physical therapy students. The students used thrust spinal manipulation 36.2%, 26.1%, and 13.3% of the time at the initial visit, interim session, and discharge session, respectively. Figure 2 displays the thrust spinal manipulation and lumbar stabilization exercise rates across the course of care. Manipulation procedures were used at a greater rate early on in the course of care and then reduced, with lumbar stabilization exercises being the treatment of choice in the later stages of physical therapy care.

Integration of Thrust Spinal Manipulation Into Physical Therapist First Professional Education

Curricula require constant adaptation to incorporate emerging evidence into clinical management courses. We have briefly described a method of education in thrust spinal manipulation and a system to monitor student clinical behavior and patient outcomes during the clinical experience. The educational method tries to foster the use of peer-reviewed evidence when making treatment decisions. In particular, the course emphasis and laboratory instructional time focused on interventions with supporting evidence, whereas procedures with limited evidence (ie, physical agents, traction) were mentioned but not emphasized nor practiced in these labs. There is a myriad of possible thrust and nonthrust spinal manipulation procedures and an equal number of paired complex diagnostic decision trees that have been designed around these procedures. In the authors' experience, this has led to ''paralysis by analysis''; in other words, if not every physical examination finding fit into a complex diagnostic decision tree, the student would choose not to intervene with thrust spinal manipulation. Therefore, it was agreed by the faculty to limit the number of manual therapy procedures used in the course. The procedures chosen were based on evidence where available, which was limited with the exception of the lumbopelvic region manipulation.[10,18,19] Other proce-

dures were selected, based on both an impairment-based model and the faculty perceptions of the relative ease of learning these procedures. The students described in this report demonstrated utilization rates for thrust spinal manipulation and nonthrust spinal manipulation in patients with LBP that were substantially higher than previously reported by practicing physical therapists.[3,23,26,27] In addition, the patient outcomes in ROM, pain, and disability were clinically meaningful (ie, change scores exceeded the minimum clinically important difference for these instruments).[21] This occurred with no adverse events reported by the students or clinical instructors. It is important to note that no cause-effect relationship can be considered; however, these results are encouraging and suggest that continued efforts in this area may be worthwhile.

As physical therapy educators, we believe that a framework of evidence-based practice must be instilled early on in the physical therapist professional degree curriculum. This particular example of a physical therapy intervention has supporting evidence, yet is underutilized, providing an opportunity for faculty and students to explore the barriers that prevent the conversion of evidence into clinical practice. The use of a minimum data collection forms provides faculty with the opportunity to monitor their own educational outcomes and assess if teaching strategies and behaviors are effective in promoting the desired student clinical decision making. This process also encourages students to monitor and reflect on the outcomes of their care, an important component of evidence-based practice. Patients who do not achieve a successful outcome provide an opportunity to examine the clinical decision-making process and attempt to determine what alternative strategies may have been more appropriate. The minimum data forms do not have complete patient examination data, which may make it difficult to ultimately determine what the optimal clinical decision making should have been. Having students present individual patient case reports with more complete data may be a strategy to examine the decision-making process in greater depth.

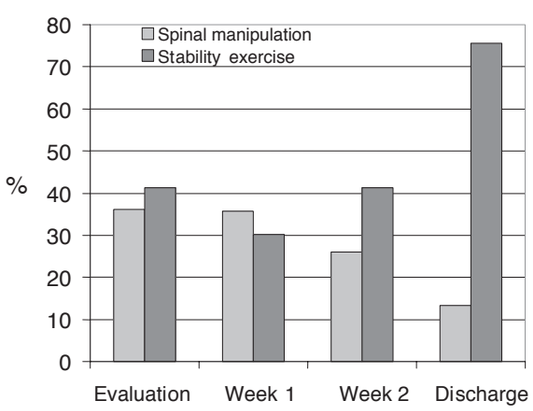

FIGURE 2. Spinal manipulation and spine stabilization exercise rates across the course of care.

Additionally, the ability to pool information and reflect on practice patterns on a larger level at the conclusion of the clinical experience provides a mechanism to discuss group- and societal-level decision making in healthcare. For example, in the current report we noted that thrust spinal manipulation was used at greater rates early on in the course of care and then gradually reduced, with an increasing emphasis on stabilization exercises to approximately 75% by discharge (Figure 2). During the clinical reflection and review time, the students were queried on the reported utilization rates of stabilization exercises. They were then asked, based on published research on specific stabilization exercises demonstrating substantial decreased recurrence rates,[24] how they viewed this utilization rate (eg, is it too high or too low?). The class and instructors then looked at the data from the perspective of a third-party payer or a clinic manager to explore how these data could be used to improve clinic quality. Future research should explore in a more formalized manner student clinical decision making in the LBP population. We are currently developing mechanisms to monitor student behavior and patient outcomes across a variety of conditions and with a number of physical therapist educational programs.

It appears that through education it may be possible to modify the utilization rates of thrust spinal manipulation in individuals with LBP; however, it is unclear if this is occurring on a larger scale. Boissonnault and Bryan[8] surveyed first professional physical therapist education programs recognized by the Commission on Accreditation in Physical Therapy Education (CAPTE). Fifty-one (44%) programs responding to the survey included joint manipulation in their curriculum.[8] The 65 (56%) programs not including joint manipulation in their curriculum reported reasons such as belief that it was not an entry-level skill (45%), lack of time (26%), lack of qualified faculty (7%), and perceived lack of scientific evidence regarding efficacy (7%).[8] More recently, Boissonnault and Bryan[7] described the availability of thrust joint manipulation clinical education opportunities for physical therapist professional students. The authors reported that program academic coordinators of clinical education cited lack of qualified instructors as the number-one barrier to finding sites that offered thrust joint manipulation.[7] Furthermore, clinical instructors who did not teach thrust joint manipulation cited reasons that included the belief that it is not an entry-level skill (57%), lack of qualified staff (53%), liability concerns (46%), and students not being academically prepared (41%). Taken in concert, these surveys[7,8] suggest that there continue to be

barriers between emerging evidence and the incorporation of evidence into educational systems.

CONCLUSION

Effective management of patients with LBP continues to be a challenging problem for physical therapists. It appears that thrust spinal manipulation is an intervention strategy that has some benefits, but is often used at lower-than-expected rates. Because therapists tend to practice based on strategies learned in their professional training, integration of thrust spinal manipulation into first professional degree curricula may offer the best opportunity to increase use of this evidence-based intervention. In contrast to previous reports, the physical therapist professional degree students described used thrust spinal manipulation at rates that are more consistent with current evidence and clinical practice guidelines. The method of instruction and monitoring of utilization and outcomes may be an effective way to facilitate behavior change towards a more evidence-based approach in the management of low back disorders. Further research is needed to compare this model with other teaching methods as well as to assess longer-term practice pattern behaviors and patient outcomes.

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Appendix A

Basic or Core Set of Spinal Manipulation Procedures

Supine LumboPelvic Thrust Manipulation

Sidelying Rotational Thrust Manipulation

Sidelying Extension Thrust Manipulation

Sidelying Flexion Thrust Manipulation

Prone PA Central Mobilization/Manipulation

Prone PA Unilateral Mobilization/Manipulation

Appendix B

Low Back Pain Minimum Data Collection

Today's Date: ☐☐ / ☐☐ / ☐☐☐☐

Demographic Information

Sex: Male O Female O

Date of Birth (year): ☐☐☐☐

Date of Onset: ☐☐ / ☐☐ / ☐☐☐☐

Prior History of Back Pain: O yes O no

Diagnosis:_____

Symptoms (check one):

O Low back symptoms only

O Low back and buttock/thigh symptoms (not distal to the knee)

O Low back and leg symptoms distal to the knee

O Post-Surgical: Surgical Procedure:_____

Date of Surgery: ☐☐ / ☐☐ / ☐☐☐☐

Week	Intervention 1 2 3 4	Pain Score	Average SLR	Flexion ROM	Oswestry
Initial	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐
1.	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐
2.	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐
3.	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐
4.	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐
5.	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐
6.	☐☐☐☐	☐☐	☐☐	☐☐☐	☐☐

Intervention

A. Patient education/instruction
B. Flexion exercises
C. Extension exercises
D. Flexibility exercises
E. Stabilization exercises
F. General conditioning exercises
G. Aerobic exercise
H. Functional Training
I. Mobilization - lumbar
J. Mobilization - sacroiliac
K. Manipulation - lumbar
L. Manipulation - sacroiliac
M. Soft tissue massage
N. Electrotherapy for pain control
O. Heat modalities
P. Cold modalities
Q. Traction – mechanical
R. Traction - Autotraction
S. De-weighting
T. Other:_____

First visit: ☐☐ / ☐☐ / ☐☐☐☐

Last visit: ☐☐ / ☐☐ / ☐☐☐☐

Number of visits: ☐☐

Discharge: ☐☐ / ☐☐ / ☐☐☐☐

Demographic Data

Dates: For dates, use the format MM / DD / YYYY with a "0" in the first box if the month or day is a single digit. For the "date of symptom onset," if the patient cannot recall an exact or approximate onset, use the first day of the month when the symptoms began. If the patient cannot recall the month, use 01 / 01 / YYYY.

Prior History of LBP: Note whether or not the patient has had previous episodes of low back and/or leg pain that caused limitations in the patient's function.

Sex: Shade in the appropriate circle.

Symptoms: Check the circle that best describes the patient's symptoms. If post-surgical, note the procedure and date of the procedure.

Clinical Data

The data are set up to record at weekly intervals for the first six weeks of therapy. Each row of data represents a given week. If the patient is seen somewhere in the interval, round up to the higher week number. If the patient is not seen during a given week, leave that row empty and fill in all other available data. If the patient is seen twice or 3 times in one week, use the latest visit in the data for that week.

Treatments: For each week, choose from the list labeled A-T the 4 major treatments used during that week. When more than 4 of the treatments are used, list the 4 of highest priority according to the therapist's opinion of those treatments that have most influence on the patient's recovery. If a treatment is performed that does not meet any of the categories listed, use the 'other' category and indicate what the treatment was on the line provided.

Pain Score: Record the patient's rating of the worst pain over the past 24 hours using a 0-10 scale where 0 represents no pain and 10 represents the worst imaginable pain.

Average SLR: The patient is supine with both legs extended. The therapist places the inclinometer along the anterior tibia, just distal to the tibial tuberosity. Set the inclinometer to '0'. Passively lift the patient's leg to the maximal tolerable level of hip flexion while maintaining knee extension. The degree of hip flexion is noted. Both legs are tested and the average range of motion is recorded.

Flexion ROM: The patient is standing. The therapist positions the inclinometer over the spinous process of the L_1 vertebra. The patient is instructed to bend forward as far as possible without flexing the knees. The amount of total flexion range of motion is recorded.

Oswestry: The Oswestry Low Back Pain Disability Scale is a measure of disability due to low back pain. The Oswestry contains 10 items. Each item is scored from 0-5 with higher numbers indicating greater levels of disability. If all items are completed, the total score is multiplied by 2 and expressed as a percentage. If some items are not completed by the patient, the total score is divided by the total points possible and expressed as a percentage.