Development and outcomes of a program to translate the evidence for spinal manipulation into physical therapy practice

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Objectives: To describe a program to translate evidence into practice for the use of manipulation with a sub-group of patients with low back pain and report the program's outcomes following implementation. We compared outcomes based on appropriate inclusion in the program and compliance with the evidence being translated.

Methods: The evidence translation program was based on evidence that patients meeting two criteria (duration of symptoms <16 days, no symptoms distal to knee) were likely to respond to a physical therapy that included manipulation in the first two visits. Implementation addressed potential barriers with referring physicians, physical therapists, and scheduling staff to this evidence. Outcomes for patients in the program were tracked following implementation. Process outcomes were appropriateness of inclusion (met both criteria), compliance with evidence for providing thrust manipulation in the first two visits, and number of physical therapy visits. Clinical outcomes were based on Oswestry scores from the first, interim (after two to three visits), and final visit.

Results: A total of 577 patients entered the evidence translation program (mean age = 43.0, 56.8% female); 79.5% were appropriate inclusions and 83.0% received manipulation. The use of manipulation was associated with fewer visits (mean difference = 0.54 visits, 95% CI: 0.037, 1.04, $P = 0.035$), and appropriate inclusion was associated with greater Oswestry change (mean difference at the final visit = 6.6 points, 95% CI: 1.6, 11.6; $P = 0.010$).

Discussion: Implementing evidence into practice is difficult; however, barriers can be anticipated and overcome. Tracking the outcomes of an implementation program is critical to evaluating its benefit to patients. Additional research using experimental designs are necessary to evaluate the effectiveness of various treatments implemented in physical therapy practice.

Keywords: Low back pain, Manipulation, Evidence-based practice, Knowledge translation

Introduction

Low back pain (LBP) is an extremely common and costly condition, accounting for approximately 2–3% of all physician visits with annual health care expenditures rivaling those for the treatment of cancer in the United States.^{1–3} Health care costs for treatment of LBP continue to rise, yet rates for chronic symptoms and disability due to LBP are also increasing,^{4–6} indicating a need to identify more cost-effective management strategies than those currently being used. A proposed strategy is the early use of physical therapy, including spinal manipulation and exercise, especially for a sub-group of patients with LBP who appear highly likely to benefit from this treatment. This sub-group of patients was initially described by Flynn and colleagues⁷ as patients in the age group of

18–60 years with at least four out of five clinical characteristics present (Table 1). This five-factor sub-group definition was validated in a randomized clinical trial as predictive of rapid success with manipulation and exercise (defined as 50% reduction in disability within one week) with greater improvements in pain and disability and reduced utilization of additional treatments observed at a six-month follow-up.⁸ These findings support the hypothesis that patients with LBP who fit this sub-group might be most effectively managed with early referral to physical therapy for manipulation and exercise. Evaluation of the impact of translating this management strategy into clinical practice has been limited.

Moving research evidence into clinical practice is a notoriously slow and erratic process with numerous potential barriers.⁹ One barrier related to the implementation of the five-factor sub-group definition as a decision aide for referral to physical therapy is its

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Table 1 Criteria for identifying the sub-group of patients with low back pain who are likely to respond to early use of spinal manipulation and exercise^{7,10}

Five-factor definition of sub-group (at least four out of five factors must be present)	
Factor	Definition of Positive
Duration of current LBP symptoms	<16 days duration
Extent of LBP symptoms	Not having symptoms below the knee(s)
Fear-avoidance beliefs about work	FABQW score <19
Lumbar spine mobility	At least one lumbar segment judged hypo-mobile
Hip internal rotation range of motion	At least one hip >35°
Two-factor pragmatic definition of sub-group (both factors must be present)	
Factor	Definition of Positive
Duration of current LBP symptoms	<16 days duration
Extent of LBP symptoms	Not having symptoms below the knee(s)

FABQW = Fear-Avoidance Beliefs Questionnaire Work subscale.

complexity. The definition involves only five variables but not all are collected in routine clinical circumstances.¹⁰ Anticipation of this barrier motivated further refinement of the sub-group definition to include two factors (Table 1). The two-factor definition maintained acceptable accuracy for identifying the sub-group of patients with LBP likely to experience rapid success with manipulation and exercise, and appears more practical for routine clinical use.¹⁰

The overall purpose of this paper is to describe an evidence translation program that was designed to implement a management strategy for patients with LBP based on this evidence within one integrated health care delivery system. Specifically, we will (1) describe the program used to address potential barriers to implementation with physicians, physical therapists, and staff and (2) report the clinical outcomes of patients managed following implementation and compare outcomes of patients whose management was compliant to the evidence related to the use of manipulation with this sub-group of patients versus those whose management was non-compliant and based on meeting the two-factor criteria for the sub-group or not.

Methods

Setting

The evidence translation program took place within the Park Nicollet Health Services (PNHS); a non-profit, integrated health care system located in Minneapolis, MN and surrounding suburbs. The PNHS has 20 primary clinics supported by 10 physical therapy clinics employing more than 70 physical therapists who provide treatment to more than 25 000 patients annually. The data reporting for the program was approved by the Institutional Review Board of PNHS and qualified for exempt status.

Principles for developing the evidence translation program

The evidence translation program was designed with the goals of increasing the number of patients with LBP referred to physical therapy that fit the sub-group likely to respond rapidly to manipulation and

exercise and to standardize the physical therapy treatment program for this sub-group in order to improve clinical outcomes. For implementation of the evidence translation program, three clinician or staff groups were identified where barriers to implementation could be encountered. First, physicians who were likely to be the point of entry into the health care system for patients with LBP who fit the sub-group criteria would need to identify and promptly refer these patients; second, staff members who schedule physical therapy appointments would need to understand the need for prompt access to physical therapy for patients who met the sub-group criteria; and third, the physical therapists would need to provide the treatment that was adherent to the evidence for these patients. Each of these potential barriers was targeted by the evidence translation program as outlined below.

Initially the evidence translation program was implemented at four physical therapy clinics. These clinics were chosen based on close proximity to an emergency room, urgent care, or primary care facility likely to see a high proportion of patients with LBP who fit the two-factor sub-group definition of a likely responder to manipulation and exercise. As the training continued, more clinics were added once the included clinics felt comfortable with the process. The physical therapist training process began in January 2008 and was completed in June 2008. The training process for physicians within the PNHS system was completed in August 2008.

Training for physical therapists

Training provided to physical therapists was designed to address variability in the treatment approaches used within PNHS for patients with LBP. Training was conducted within each participating physical therapy clinic and began with a presentation of the current evidence about the identification of the sub-group of patients with LBP likely to respond to a treatment program of manipulation and exercise. Physical therapists were educated using a 60-minute didactic presentation of the evidence supporting the sub-group identification factors (Table 1), and the

treatment supported by the evidence for this sub-group. An additional 30-minute didactic presentation was used to provide an overview of knowledge translation program and data collection process. Physical therapists were given written materials for ongoing reference.

Five treatment sessions for patients who fit the sub-group were recommended to the physical therapists based on the randomized trial by Childs and colleagues.⁸ The first two sessions were recommended to include spinal manipulation directed to the lumbosacral region and instruction in a range of motion (ROM) exercise to be performed by the patient several times a day. A randomized trial by Cleland *et al.*¹¹ found equivalent clinical outcomes among patients with LBP who fit the sub-group definition regardless of the particular spinal manipulation technique used, but did find superior outcomes when thrust manipulation was used versus a non-thrust (i.e. mobilization) technique. Therefore, physical therapists were instructed in two thrust manipulation techniques, a side-lying and a supine technique described in detail elsewhere.¹¹ Instruction to physical therapists for delivering the manipulation were based on previous clinical trials.^{8,11} The first manipulation technique would be performed on the patient's more painful side. After the technique was performed, the physical therapist would note if a click or 'pop' was heard or felt, and if so the manipulation intervention was considered complete. If not, the patient would be repositioned and the manipulation was attempted again. If no click or pop was noted in the second attempt the physical therapist would perform the manipulation on the opposite side. A maximum of two manipulation attempts per side were recommended. Physical therapists were instructed to include thrust manipulation on the first visit, and at subsequent visits at their discretion. Physical therapists were instructed to teach the patient ROM exercises to perform intermittently throughout the day to accompany the manipulation. Options included tilting of the pelvis from a hook-lying position or lumbar flexion-extension from a quadruped position.

The final three physical therapy treatment sessions were recommended to include an exercise program of trunk strengthening and stabilization exercises. These exercises are described in detail elsewhere,⁸ but could include general strengthening for the lumbar erector spinae, multifidi, oblique abdominal, and quadrates lumborum muscles, as well as specific exercises to isolate contraction of the deep abdominal muscles. Physical therapists were instructed that other treatments and exercises could be applied as deemed appropriate.

The second training component for physical therapists was a 60–90 minute interactive hands-on

training session where the supine and side-lying manipulation techniques were presented, demonstrated, and practiced. The hands-on training was conducted by two physical therapists trained in spinal manipulation and experienced with using manipulation in routine clinical practice. A follow-up hands-on session (approximately two weeks after the first) was available to any physical therapist who felt a need for additional practice. The second session was used by three clinics. All physical therapists were encouraged to practice with co-workers and follow-up with the instructors with any questions. A physical therapist expressing enthusiasm for the program within each clinic was designated by the instructors as the 'Clinical Champion'. The Clinical Champion in each clinic was tasked with overseeing the data collection, communicating with referring physicians, assisting with marketing of the program and training any new physical therapists in the clinic.

Training for physicians

The next concern addressed by the evidence translation program was barriers to physician referral of patients to physical therapy of this sub-group of patients with LBP. Perceived barriers to referral were that primary care physicians either waited to refer patients with acute LBP to physical therapy or did not refer patients with LBP at all. Training related to the evidence translation program was provided to approximately 150 physicians, physician assistants, and nurse practitioners in emergency room, urgent care, and primary care facilities located close to physical therapy clinics participating in the evidence translation program. Each provider was employed by PNHS. Training consisted of a discussion of the current state of LBP management in the United States and the evidence related to the sub-group of patients with LBP who are likely to respond rapidly and significantly to a physical therapy program of manipulation and exercise. The training described in detail the program to standardize physical therapy care around this evidence that was being implemented in PNHS. Physicians were instructed to refer patients in the age group of 18–60 years with complaints of LBP who met the two-factor sub-group definition (i.e. symptom duration <16 days and no symptoms below the knee). Training also emphasized improved access to physical therapy in the evidence translation program to address concerns that patients fitting this sub-group could be guaranteed access within 48 hours of referral. New physical therapy referral forms were provided that included a check box to indicate whether the patients fit the two-factor definition and were appropriate for the program. These patients would be assured access into a participating physical therapy clinic within 48 hours of calling for an appointment.

Training for scheduling staff

Scheduling for physical therapy appointment within PNHS is managed by a centralized call center. Training for call center staff was designed to ensure prompt physical therapy access for patients referred by physicians into the evidence translation program. Training provided to schedulers included a description of the program and the importance of prompt access. The new referral form distributed to physicians that allowed indication of whether the patient was appropriate for the evidence translation program was described, and staff were educated to ask anyone calling for a new appointment for LBP if the box had been checked indicating the patient should be entered in the program. Call center employees were further instructed to identify a 30-minute spot for the initial visit as well as two more appointment spots for a total of three visits in a two-week time frame for patients who are appropriate for the evidence translation program. Call center staff instructed patients to arrive 15 minutes before their appointment time to complete appropriate paper work. If no appointments were available within 48 hours, the Clinical Champion for the clinic closest to the patient was contacted in an effort to find an appointment that would meet the 48-hour rule. This happened rarely and all patients were able to ultimately be accommodated within 48 hours unless it was the patient's preference.

Patients

Patients included in the evidence translation program were those referred to the program by a referring provider or identified by the physical therapist at the initial assessment as appropriate for the program. Although we provided guidelines for inclusion in the program to physicians, not all patients referred to the program actually met the two-factor rule when examined in physical therapy and physical therapists maintained discretion to treat patients as they saw fit. Therefore the program ultimately included patients who were not appropriate inclusions in the knowledge translation program and/or did not receive treatment consistent with the program recommendations. Analyses included patients enrolled in the program between 1 August 2008 and 31 December 2010.

Standardized physical therapy care process

The standardized care process began with patients completing baseline self-report measurements. A flow sheet was developed to help physical therapists collect appropriate data. Baseline data collection included an intake demographic and history form that recorded the presence or absence of sub-grouping factors including the distal-most extent of symptoms and the date of onset of current episode as well as additional demographic variables including age, sex,

and prior history of LBP. The modified Oswestry Disability Index (ODI)¹² was used to assess disability related to LBP. The ODI is scored from 0 to 100 with higher numbers indicating greater disability. An improvement of 50% on the ODI from the baseline score has been validated as defining a 'successful' outcome,¹³ and this definition was used to determine a successful clinical outcome for the QI program. The ODI was collected at baseline, and on the third and fifth physical therapy visits. An ODI was collected at the second visit if a patient indicated that he or she wished to be discharged at that time. The fear-avoidance beliefs questionnaire work subscale (FABQW)¹⁴ was assessed at baseline. The FABQW consists of seven items and is scored from 0 to 42 with higher numbers indicating greater fear-avoidance beliefs related to work activities. The FABQW is a sub-group factor in the five-factor definition and is considered positive when the score is <19.

Additional physical examination procedures including the remaining sub-group definition factors were performed following completion of the self-report forms. Hip internal rotation passive ROM was examined with the patient prone and the hip in neutral adduction. The knee was flexed to 90° with a single inclinometer placed along the lateral lower leg. The hip was allowed to passively internally rotate until the motion stopped or movement was noted in the pelvis. This procedure has excellent reliability.¹⁵ This factor was considered present when at least one hip had internal rotation ROM >35°. Mobility of the lumbar spine was assessed with the patient prone. The physical therapist applied a posterior-to-anterior force over the spinous process of each lumbar vertebra, judging each vertebra to be hyper-mobile, hypo-mobile, or have normal mobility. These judgments have been shown to have acceptable reliability.¹⁶ This factor was considered positive if at least one vertebra was judged hypo-mobile. Additional examination procedures were performed at the physical therapist's discretion. It was recommended that treatment should begin after completion of the examination.

Outcomes measures

Outcomes of the evidence translation program included both process and clinical measures. Process outcome measures were appropriate inclusion in the program based on the two-factor criteria and the use of thrust manipulation during physical therapy, and the number of physical therapy visits. Compliance with using manipulation was determined through reviews of patient charts after discharge from physical therapy and was based on the use of thrust manipulation during at least one of the first two first physical therapy visits. Previous research found that this definition of compliance was related to clinical

outcomes in a cohort of patients with occupational LBP.¹⁷ Additional interventions provided were recorded in the following categories: spinal mobilization (i.e. non-thrust), soft tissue mobilization/massage, ROM exercise, trunk strengthening/stabilization exercise, repeated end-range (i.e. directional) exercise, mechanical traction, heat modality, cold modality, ultrasound, or sensory electrical stimulation.

Clinical outcomes were determined from ODI scores. The ODI collected after two to three visits was considered the interim clinical outcome assessment. For patients who attended at least five visits the ODI collected on the fifth visit or at the end of treatment was considered the final clinical outcome assessment. For patients who attended fewer than five visits the ODI collected after two to three visits was considered the final clinical outcome.

Feedback to physical therapists

After discharge, clinic staff reviewed the patient's paper chart and extracted data to a centralized database. Reports were provided quarterly to each clinic outlining the total number of LBP patients enrolled in the evidence translation program, the average number of physical therapy visits, and the percentage of patients who met the 50% ODI improvement threshold defining success at the third and fifth visits. Data were presented for each individual clinic and for the all participating clinics to allow a benchmark of performance relative to the whole.

Statistical analysis

We calculated descriptive statistics for patients in the knowledge translation program including age, sex, initial ODI score, and status on each of the subgrouping factors. Patients were categorized as appropriate for inclusion in the program if they fit the two-factor sub-group definition (duration of symptoms <16 days and no symptoms below the knee). Patients who did not meet both of these criteria were categorized as inappropriate inclusions. Based on the chart reviews we categorized the physical therapy treatment as compliant with the evidence if spinal manipulation was provided at one or both of the first two physical therapy visits. If manipulation was not received during one of the first two visits the treatment was categorized as non-compliant.

We calculated descriptive statistics for process and clinical outcomes for all patients. Clinical outcomes included the ODI scores from the interim and final assessments and the change from baseline ODI to interim and final assessment. We also categorized the clinical outcome at each assessment as successful or non-successful based on a previously-validated threshold of success requiring at least 50% improvement on the ODI from the baseline score.¹³ Percent ODI improvement was calculated as the change in

ODI divided by the baseline ODI. We used only available data without imputation of missing values.

We compared descriptive, process, and clinical outcomes between patients based on appropriate inclusion in the knowledge translation program and based on compliant physical therapy treatment. Comparisons were made with independent *t*-tests or chi-square tests of association as appropriate for the data. Comparisons of process (number of visits) and clinical (ODI score) outcomes were made using ANOVA procedures. In each procedure we used appropriate inclusion and use of thrust manipulation as independent variables and first examined the interaction term between these appropriate inclusion and manipulation to evaluate the hypothesis that superior outcomes would be found among patients who were appropriate inclusions and received thrust manipulation. Number of visits was compared using a two-way ANOVA. We examined the interaction between appropriate inclusion and manipulation along with their main effects. Clinical outcomes were evaluated using separate two-way ANCOVA procedures with adjustment for baseline ODI scores. We used separate ANCOVA models to examine change from baseline ODI score to the interim and final scores. For each model we first examined the interaction between manipulation and appropriate Is something missing here – “appropriate” what? and then evaluated main effects for both variables. Finally, we compared the proportion of patients achieving a successful ODI outcome based on appropriateness of inclusion and use of thrust manipulation using chi-square analyses.

Results

Descriptive variables for all patients in the knowledge translation program

A total of 577 patients were included in the evidence translation program during the period of this analysis. Almost all patients (98.0%) were referred into the program by a physician, the remaining being added by their physical therapist. Baseline characteristics are outlined in Table 2. Figure 1 depicts the categorization of the patients based on whether they were appropriate inclusions in the knowledge translation program or not and based on receiving thrust manipulation in the first two physical therapy visits. Among the 577 patients, 118 (20.5%) were inappropriate inclusions based on failing to meet the two-factor sub-group definition and 459 (79.5%) were appropriate inclusions. The mean number of physical therapy visits received was 3.2 (SD = 2.0). Ninety-five patients (16.5%) attended only one visit, 295 (51.1%) attended two to three visits, 131 (22.7%) attended four to five visits, and 56 (9.7%) attended more than five visits. An additional 23 patients were not included in further analyses because the treatment

Figure 1 Outline of patients included in the knowledge translation program and categorization based on appropriate inclusion in the program and receiving manipulation.

notes were not available for review, leaving 459 patients on whom treatment data and clinical outcomes were examined. Among these patients, 381 (83.0%) received thrust manipulation during the first two visits and 78 (17.0%) did not receive manipulation. Additional interventions received during physical therapy are outlined in Table 3.

Comparison of descriptive variables based on appropriate inclusion and thrust manipulation

Patients who were appropriate inclusions did not differ from those who were inappropriate with respect to age (43.1 vs 42.7, $P = 0.80$) gender (56.0% vs 60.2% female, $P = 0.41$) or baseline ODI (45.5 vs 46.7, $P = 0.48$). Patients who were appropriate inclusions were more likely to receive thrust manipulation within the first two visits (86.1%

vs 71.4%, $P = 0.001$). With respect to other physical therapy interventions, patients who were appropriate inclusions were more likely to receive ROM exercises, and less likely to receive directional exercises or mechanical traction (Table 3).

Patients who received manipulation within the first two visits did not differ from those who did not based on age (43.1 vs 44.1, $P = 0.49$) or baseline ODI (46.2 vs 44.8, $P = 0.49$). Patients receiving manipulation within the first two visits were more likely to be male than those who did not (45.7% vs 28.2%, $P = 0.004$), were more likely to receive ROM exercise, and less likely to receive mechanical traction or non-thrust mobilization (Table 3).

Comparison of outcomes based on appropriate inclusion and thrust manipulation

Comparison of the number of visits based on appropriate inclusion and manipulation within the first two visits included the 459 patients with more than one physical therapy visit and treatment data available. Overall, these patients attended a mean 3.6 visits (SD = 1.9) (Table 4). Group means based on the interaction between appropriate inclusion and manipulation are displayed in Fig. 2. The interaction was not significant ($P = 0.55$). Group means based on main effects for appropriate inclusion and manipulation are outlined in Table 4. There was no difference in the number of visits based on appropriate inclusion in

Table 2 Baseline characteristics of subjects referred into the evidence translation program ($n = 577$)

Characteristic	
Gender (n , % female)	328 (56.8%)
Age in years (mean, SD)	43.0 (12.4)
Oswestry disability index score (mean, SD)	46.4 (16.2)
Prediction rule criteria present (n , %)	
Duration of current symptoms <16 days	486 (84.2%)
No symptoms below the knee(s)	506 (87.7%)
FABQW score <19	365 (63.3%)
Lumbar spine hypo-mobility present	399 (69.2%)
Hip internal rotation range of motion >35°	401 (69.5%)
Met the two-factor criteria sub-group definition	459 (79.5%)

Figure 2 Mean number of physical therapy visits based on appropriateness of inclusion in the knowledge translation program and receiving thrust manipulation in first two physical therapy visits. The interaction between appropriateness and manipulation in the two-way ANOVA was not significant ($P = 0.55$).

the program (mean difference = 0.27 visits, 95% CI: -0.24, 0.77, $P = 0.30$). There was a significant difference in the number of visits based on receiving manipulation. Patients receiving manipulation within the first two visits had fewer visits than patients who did not (mean difference = 0.54 visits, 95% CI: 0.037, 1.04, $P = 0.035$).

Clinical outcome (ODI) scores were available for 318 (69.3%) at the interim assessment and 295 (64.2%) at the final assessment. Patients with clinical outcome scores did not differ from excluded patients with respect to age, gender, initial ODI score, or manipulation, but were more likely to be appropriate inclusions (82.1% vs. 71.9% for the interim outcome, $P = 0.011$; 81.9% vs 74.0% for the final outcome, $P = 0.041$). Mean ODI score for all patients was 20.2 (SD = 16.2) at the interim assessment and 15.6 (SD = 14.8) at the final assessment (Table 4). The interaction between appropriate inclusion and receiving manipulation within the first two visits was not

Figure 3 Mean change in ODI scores at the interim assessment adjusted for baseline ODI scores based on appropriateness of inclusion in the knowledge translation program and receiving thrust manipulation in the first two physical therapy visits. The interaction between appropriateness and manipulation in the two-way ANCOVA was not significant ($P = 0.62$).

significant for either the interim or final ODI score (Figs 3 and 4, respectively). There was a significant main effect for appropriate inclusion at both assessment times. At the interim assessment patients who were appropriate inclusions in the knowledge translation program experienced a mean 6.0 more points of change in the ODI adjusted for baseline scores (95% CI: 1.1, 10.9; $P = 0.017$). At the final assessment the adjusted mean difference was 5.9 points (95% CI: 0.96, 10.8; $P = 0.019$) favoring the patients who were appropriate inclusions (Table 4).

Overall rates of successful outcomes based on achieving at least 50% improvement in ODI score from baseline were 61.3% at interim assessment and 73.9% at the final assessment (Table 4). A significant difference in the rates of successful outcome at the interim assessment existed between patients who were appropriate inclusions and those who were inappropriate inclusions ($P = 0.024$), otherwise the rates of successful outcome did not differ based on appropriateness of inclusion or receiving manipulation.

Discussion

We were able to implement a process to address the barriers to the implementation of evidence regarding

Table 3 Interventions received by patients in the knowledge translation program

Intervention category	All patients (n = 459)	Appropriate inclusion (n = 361)	Inappropriate inclusion (n = 98)	Received manipulation (n = 381)	Did not receive manipulation (n = 78)
ROM exercise*†	418 (91.1%)	337 (93.4%)	81 (82.7%)	354 (92.9%)	64 (82.1%)
Directional exercise*	110 (24.0%)	77 (21.3%)	33 (33.7%)	93 (24.4%)	17 (21.8%)
Stabilization exercise	322 (70.2%)	257 (71.2%)	65 (66.3%)	272 (71.4%)	50 (64.1%)
Non-thrust manipulation†	243 (52.9%)	193 (53.5%)	50 (51.0%)	192 (50.4%)	51 (65.4%)
Soft tissue mobilization	130 (28.3%)	105 (29.1%)	25 (25.5%)	110 (28.9%)	20 (25.6%)
Mechanical traction*†	52 (11.3%)	35 (9.7%)	17 (17.3%)	37 (9.7%)	15 (19.2%)
Heat	38 (8.3%)	26 (7.2%)	12 (12.2%)	34 (8.9%)	4 (5.1%)
Cold	110 (24.0%)	91 (25.2%)	19 (19.4%)	90 (23.6%)	20 (25.6%)
Ultrasound	120 (26.1%)	98 (27.1%)	22 (22.4%)	96 (25.2%)	24 (30.8%)
Electrical stimulation	124 (27.0%)	97 (26.9%)	27 (27.6%)	98 (25.7%)	26 (33.3%)

*Indicates significant difference between patients who were or were not appropriate inclusions based on meeting the two-factor criteria. †Indicates significant difference between patients who received manipulation within the first two visits or did not ($P < 0.05$).

Figure 4 Mean change in ODI scores at the final assessment adjusted for baseline ODI scores based on appropriateness of inclusion in the knowledge translation program and receiving thrust manipulation in first two physical therapy visits. The interaction between appropriateness and manipulation in the two-way ANCOVA was not significant ($P = 0.29$).

the use of spinal manipulation for a sub-group of patients with LBP. The process resulted in a high proportion of appropriate patient referrals by physicians, and a high level of compliance with the use of thrust manipulation by the physical therapists. Overall the majority of patients included in this program had a successful outcome based on changes in the Oswestry score. We found that two variables (referral of appropriate patients and the use of manipulation) were related to process and clinical outcomes.

The design of this study does not permit us to draw conclusions about the effectiveness of the manipulation and exercise treatment program, but does create an opportunity to reflect on the process of developing a program to implement this program. Our goal was to create a logical and streamlined program for physical therapists, physicians, and our patients. Targeting knowledge translation methods and messages to specific audiences is likely important for success,^{18,19} and we attempted to address specific barriers to translation that might exist with each of these groups.

We anticipated that this exercise and treatment program would represent a substantial shift in practice patterns for patients with acute LBP for some physical therapists. We therefore believed it was key that physical therapists understood the evidence supporting this treatment program and its implications for practice. Regular use of outcome measures such as the Oswestry was uncommon within several of our physical therapy clinics. We also anticipated that some physical therapists would require opportunities to enhance their motor skills in the delivery of thrust manipulation. We attempted to address each of these issues through a combination of didactic and hand-on training with encouragement for physical therapists to practice with each other. We found the response of physical therapists to the program to be generally positive. Anecdotally we noted a degree of frustration with the additional paperwork required by the program. This is likely reflected in our rates of successful outcome collection at the follow-up visits.

We expected the physicians would be unaware of the literature supporting the use of a physical therapy program of manipulation and exercise for a specific sub-group of patients with LBP, and it would be important to provide a clear description of the scientific evidence underlying the program. We further expected that the process must be streamlined and not require a large amount time or additional training. Anticipation of these barriers led us to implement a simple check box on the referral paper and to use the two-factor criteria for sub-group identification instead of the original five-factor criteria.¹⁰ We found the physicians to be generally quite supportive to the program. Feedback from physicians indicated that many were happy to have something to offer to patients that was evidence-based, and they particularly appreciated the opportunity to guarantee patients rapid access to physical

Table 4 Clinical outcomes of patients in the knowledge translation program

	All patients	Appropriate inclusion	Inappropriate inclusion	Received manipulation	Did not receive manipulation
Baseline					
Number of patients	459	361	98	381	78
Mean ODI score (SD)	46.0 (15.8)	46.4 (15.8)	44.4 (15.7)	46.2 (15.4)	44.8 (17.5)
Number of visits (SD)	3.7 (1.9)	3.6 (1.8)	3.8 (2.1)	3.5 (1.8)	4.1 (2.4)
Interim assessment					
Number of patients	318	260	58	267	51
Unadjusted mean ODI (SD)	20.2 (16.2)	19.0 (15.5)	25.4 (18.2)	19.8 (16.0)	22.1 (16.9)
Mean adjusted ODI change from baseline (95% CI)	22.9 (20.5, 25.4)	25.9 (23.6, 28.2)	20.0 (15.7, 24.2)	24.1 (21.8, 26.4)	21.8 (17.4, 26.1)
Successful outcome (n, %)	195 (61.3%)	167 (64.2%)	28 (48.3%)	166 (62.2%)	29 (56.9%)
Final assessment					
Number of patients	295	240	55	249	46
Unadjusted mean ODI (SD)	15.6 (14.8)	14.8 (13.9)	19.2 (18.1)	15.8 (14.8)	14.6 (15.4)
Mean adjusted ODI change from baseline (SD)	28.4 (25.9, 30.9)	31.0 (28.6, 33.3)	25.1 (20.8, 29.4)	28.6 (26.3, 30.9)	28.2 (23.8, 32.6)
Successful outcome (n, %)	218 (73.9%)	180 (75.0%)	38 (69.1%)	184 (73.9%)	34 (79.3%)

ODI = Oswestry Disability Index, successful outcome was based on achieving at least 50% improvement from baseline ODI.

therapy. There were instances of physicians using the program to gain rapid access to physical therapy regardless of appropriateness for the program. We attempted to address this with the physicians involved. The rate of appropriate referral based on the two-factor criteria was about 80%, therefore it does not appear that this was an extensive problem.

The final group we considered in designing this program was the patients. The principal issue we anticipated was seamless access to physical therapy. We were concerned that the program's effectiveness may be compromised if a physician offered the option to a patient but the patient encountered difficulty accessing physical therapy. We addressed this potential barrier by educating our scheduling center. We knew the schedulers themselves were not trained to distinguish sub-groups of LBP and we therefore sought to make this process simple by modifying our referral form. Initial feedback from the schedulers indicated concerns about meeting the requirement of the program for scheduling within 48 hours in situations when no convenient or timely option existed. Appointing a person within each physical therapy clinic (the Clinical Champion) who could be contacted in these circumstances helped alleviate this concern.

Our process and clinical outcomes provide an opportunity to evaluate the program and identify opportunities for improvement. We found a high rate of compliance in using thrust manipulation particularly for patients who were appropriate inclusions into the program. This was encouraging because several physical therapists did not routinely use manipulation prior to implementation. Although compliance with the use of manipulation was high, we also found about half of the patients received passive modalities during treatment. Use of passive modalities contradicts current evidence and has been associated with suboptimal physical therapy outcomes and increased risk of subsequent medical care.^{20,21} Only about 10% of patients in the knowledge translation program received more than five visits, which was our utilization target for patients in this program. Conversely, about 17% received only one visit, creating an opportunity for improvement in engaging patients in their physical therapy treatment program.

Similar to a previous analysis of physical therapy practice for patients with occupational LBP, we found the use of manipulation to be associated with fewer physical therapy visits.¹⁷ We also found the appropriateness of the patient for manipulation to be related to improvement in clinical outcomes (Oswestry scores). We did not identify interactions between appropriateness and receiving manipulation with respect to the number of visits or clinical outcomes. The interaction between the use of manipulation and

the appropriateness of inclusion was of particular interest in these analyses as this examined the hypothesis that the combination of the appropriate patient with the correct treatment (manipulation) would result in an optimal outcome. Our findings of non-significant interaction terms may indicate that these two variables relate to outcomes independently, however we had relatively few patients who were either inappropriate inclusions or failed to receive manipulation, making these comparisons difficult. Future studies using experimental research design are needed to examine the potential clinical benefits associated with matching manipulation to patients defined as appropriate.

Limitations

Our results should be interpreted with consideration of several notable limitations. First, the absence of control clinics that did not undergo the knowledge translation program does not allow us to comment on the effectiveness of the program itself. Similarly, we do not have data on the patterns or outcomes of care in the participating clinics prior to implementation of this knowledge translation program. We are limited to reporting and commenting on our experience in implementing this program. One of the primary challenges we encountered was successful collection of the Oswestry questionnaire beyond the baseline assessment. We were able to collect outcomes on only about 65% of patients. It is not clear how this degree of loss to follow-up may have biased our findings. We ultimately had very few patients in the program who were not appropriate inclusions and/or did not receive thrust manipulation. While this was a good outcome with respect to our training efforts, statistically it made it difficult to examine our hypothesis about the interaction between appropriate inclusion and compliance with using manipulation. Finally, our experience in attempting to implement a knowledge translation program occurred in a single health care system. The barriers and challenges we encountered are likely to some extent unique to our system.

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