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# Association Between Directional Preference and Centralization in Patients With Low Back Pain

Classifying patients with nonspecific low back pain into homogeneous treatment subgroups to help direct treatment decisions and improve prognosis and patient outcomes has been recognized as an important research and clinical priority.<sup>2,3,10,23,44</sup> One classification strategy recommended to identify and manage patients with homogeneous lumbar conditions is the patient response method.<sup>9,57</sup> The patient response method assesses the patient's report of symptoms or changes in range of motion in response to specific single

or repeated trunk movements and positioning techniques. Typically, the trunk movement that abolishes and/or reduces the patient's pain or improves the patient's lumbar range of motion is the same movement utilized by the therapist to classify the patient and direct the patient management. For example, if repeated lumbar extension movements reduce the patient's leg pain intensity and repeated flexion increases the leg pain, then the patient is categorized as an extension responder, and extension-loading strategies, such as exercise and manual mobilization or manipulation, are prescribed to treat the patient. The Mechanical Diagnosis and Therapy and treatment-based classification approaches are 2 examples of patient response classification methods.<sup>10,44</sup>

Two common examination findings that have been studied as criteria for classifying patients with low back pain, according to the patient response method, are directional preference (DP)<sup>40,41</sup> and centralization (CEN).<sup>42,44</sup> DP has been defined as either (1) a specific direction of trunk movement or posture noted during the physical examination<sup>40,41</sup> or (2) a specific aggravating and easing factor reported by the patient during the subjective history,<sup>17,19,23</sup> that alleviates or decreases the patient's pain, with or without the pain having changed location and/or in-

● **STUDY DESIGN:** Prospective, longitudinal, observational cohort.

● **OBJECTIVES:** Primary aims were to determine (1) baseline prevalence of directional preference (DP) or no directional preference (no-DP) observed for patients with low back pain whose symptoms centralized (CEN), did not centralize (non-CEN), or could not be classified (NC), and (2) to determine if classifying patients at intake by DP or no-DP combined with CEN, non-CEN, or NC predicted functional status and pain intensity at discharge from rehabilitation.

● **BACKGROUND:** Although evidence suggests that patient response classification criteria DP or CEN improve outcomes, previous studies did not delineate relations between DP and CEN findings and outcomes.

● **METHODS:** Eight therapists classified patients using standardized definitions for DP and CEN. Prevalence rates for DP and no-DP and CEN, non-CEN, and NC were calculated. Ordinary least-squares multivariate regression models assessed whether multilevel classification combining DP and CEN (DP/CEN, DP/non-CEN, DP/NC, no-DP/non-CEN, and no-DP/NC categories) predicted

discharge functional status (scale range, 0 to 100, with higher values representing better function) or pain intensity (scale range, 0 to 10, with higher values representing more pain).

● **RESULTS:** Overall prevalence of DP and CEN was 60% and 41%, respectively. For those with DP, prevalence rates for DP/CEN, DP/non-CEN, and DP/NC were 65%, 27%, and 8%, respectively. The amount of variance explained ( $R^2$  values) for function and pain models was 0.50 and 0.39, respectively. Compared to patients classified as DP/CEN, patients classified as DP/non-CEN or no-DP/non-CEN reported 7.7 and 11.6 functional status units less at discharge ( $P<.001$ ), respectively, and patients classified as no-DP/non-CEN reported 1.7 pain units more at discharge ( $P<.001$ ).

● **CONCLUSIONS:** Findings suggest that classification by pain pattern and DP can improve a therapist's ability to provide a short-term prognosis for function and pain outcomes.

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● **KEY WORDS:** computerized adaptive testing, lumbar spine, outcomes

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creased patient's lumbar range of motion. On the other hand, CEN is characterized by spinal pain and referred spinal symptoms that are progressively abolished in a distal-to-proximal direction in response to therapeutic movement and positioning strategies.<sup>1,18,44,61</sup> Recent evidence provides support for using DP or CEN as patient response classification criteria to improve patient outcomes.<sup>5,39</sup> For instance, Long et al<sup>39</sup> reported that patients with lumbar syndromes who were prescribed exercises matched to their DP determined at baseline demonstrated clinically important improvements in pain and function compared to similar patients whose exercise prescription was not matched to their DP. The efficacy for using CEN as a classification criterion was supported by Browder et al.<sup>5</sup> Their results showed improved outcomes for patients classified into an extension-oriented treatment subgroup who received extension exercise and mobilization compared to stabilization strengthening exercises during rehabilitation.<sup>5</sup>

The terms "DP" and "CEN" are closely related but are not synonymous.<sup>40,41</sup> For instance, CEN will always be accompanied by a DP (DP/CEN); however, DP may be determined in the absence of CEN (DP/non-CEN). A primary difference between the 2 operational definitions is that DP may include assessment of change in pain intensity without consideration of change in pain location, and CEN does not.<sup>1,18,38,40,41</sup> Data suggest that this is an important and clinically relevant distinction.<sup>62</sup> DP, which allows for more encompassing inclusion criteria compared to CEN, may identify a similar yet different and broader category of patients, as shown by differences in prevalence rates for DP and CEN, prognostic value, and treatment effects.<sup>5,15,19,39</sup>

Despite differences in decision rules to judge DP and CEN, previous studies frequently use both terms synonymously for data analyses and result interpretation and have not delineated associations between DP and CEN and clinical outcomes.<sup>4,19,34,39</sup> For example, in a recent

study investigating the prognostic value of DP and CEN, Long et al<sup>39,40</sup> defined each term using different examination criteria; however, patients demonstrating either DP or CEN were collapsed and analyzed as 1 subgroup, which might have confounded the results reported by the authors for elucidating the prognostic value of each factor.<sup>39,40</sup> Similarly, George et al,<sup>19</sup> using the treatment-based classification approach, classified patients with acute lumbar pain into a specific exercise subgroup in which 50% of the patients experienced CEN of symptoms and 50% reported a DP in the absence of CEN. The authors reported that the only difference between patients classified by CEN or DP was that patients experiencing CEN were more likely to have leg pain compared to patients classified by DP.<sup>19</sup> However, in their pain and disability regression models, both factors were collapsed as 1 independent variable, which might have impacted the interpretation of their results. For instance, it is unclear if their findings would have resulted in a larger or smaller CEN prognostic effect if the inclusion criteria were strictly based on CEN. It is also plausible that DP might have been more important than CEN for predicting outcomes. Additional research has been recommended to study the clinical utility and effectiveness between DP and CEN as classification criteria and to provide additional insights for the management of patients with low back pain using the patient response method to classify and direct care.<sup>5,8,17,38,59</sup>

Because of the lack of clinical evidence examining the prognostic value and clinical utility between 2 common patient response classification criteria, the aims were to determine (1) the prevalence of directional preference or no directional preference (no-DP) observed during the initial evaluation of patients with nonspecific low back pain whose symptoms centralized, did not centralize, or could not be classified by pain pattern (NC), (2) the effect of age and acuity of symptoms on prevalence, and (3) if classifying patients at intake by DP or no-DP,

combined with CEN, non-CEN, or NC, predicted functional status and pain intensity at discharge from rehabilitation. We hypothesized that more patients (ie, higher prevalence rate) would be identified by DP compared to CEN, and patients whose symptoms showed either DP/CEN or DP/non-CEN would have better functional status and less pain compared to patients whose symptoms showed no-DP.

## METHODS

### Design

**W**E CONDUCTED A PROSPECTIVE, longitudinal, observational, cohort study. We analyzed data collected from patients with nonspecific low back pain complaints who were classified and treated by 8 physical therapists working at 8 different clinical facilities. All clinicians were participating with Focus on Therapeutic Outcomes, Inc (Knoxville, TN), an international medical rehabilitation data management company.<sup>54,55</sup> The Focus on Therapeutic Outcomes Institutional Review Board for the Protection of Human Subjects approved the project. The study did not include any change in clinical practice, and patient informed consent was not required for the analyses of data collected during normal clinical practice.

### Procedures

**Clinicians** Eight physical therapists (mean age, 42 years; range, 31-59; 100% males) participated and were skilled in the use of Mechanical Diagnosis and Treatment methods.<sup>44</sup> Four physical therapists received additional postgraduate training and were Mechanical Diagnosis and Treatment diploma credentialed. Practice settings were diverse: 3 physical therapists worked in hospital-based orthopaedic outpatient clinics, 4 physical therapists were in private practice, and 1 physical therapist worked in 2 military orthopaedic outpatient clinic settings. Two therapists worked in the same practice, and 1 therapist worked

in the military and moved from one to another military clinic during data collection. All physical therapists earned a college degree in physical therapy: 50% earned master's degree in physical therapy, 1 physical therapist earned a doctorate degree in science, and 1 physical therapist earned a doctorate of physical therapy. The average number of years of clinical experience was 15 years (range, 8-40 years). All clinicians were skilled in patient response classification techniques studied. Not all therapists collected data during the entire study period (July 2007 to December 2009); 3 therapists started data collection in the summer of 2009 and 4 therapists were either transferred between clinics or had other nonpatient educational responsibilities, which interrupted their data collection.

**Subjects** Of the 618 consecutive patients treated, 34 did not start data collection, resulting in a participation rate of 95%. Reasons for not starting data collection included computer system down (8 patients), cognitive deficit (6 patients), language deficit (5 patients), visual deficit (4 patients), seen on a single occasion and provided with a home program only (3 patients), and no reason given (8 patients). Participation and completion rates, as defined by Deutscher et al,<sup>11</sup> were reported. Characteristics of the 584 patients starting data collection at intake are displayed in **TABLE 1**. Compared to patients with complete data (n = 481), patients with just intake data (n = 103; completion rate, 82%) had more chronic symptoms ( $\chi^2 = 6.3$ ,  $df = 2$ ,  $P = .043$ ), included a greater proportion of females ( $\chi^2 = 6.8$ ,  $df = 1$ ,  $P = .009$ ), received benefits from Medicaid or were private pay ( $\chi^2 = 34.3$ ,  $df = 10$ ,  $P < .001$ ), and had more pain ( $t = -3.64$ ,  $df = 139$ ,  $P < .001$ ). The groups were not different by condition complexity (quartile of the number of comorbid conditions classified as none, 1 or 2, 3, or 4 or more)<sup>21,49</sup> ( $P = .19$ ), level of fear ( $P = .59$ ), number of surgeries ( $P = .91$ ), age ( $P = 1.00$ ), and intake functional status ( $P = .25$ ) (variables described below).

TABLE 1	PATIENT CHARACTERISTICS*	
Characteristic	Intake Data Only (n = 103)	Intake and Discharge Data (n = 481)
Age (y)	50 ± 16 (18-90)	51 ± 18 (18-92)
Gender (%)†		
Male	32	46
Female	68	54
Missing	0	0
Symptom acuity (%)†		
Acute	13	22
Subacute	34	25
Chronic	53	53
Missing	0	0
Surgical history (%)		
None	84	84
1 or more	26	26
Missing	0	0
Fear of physical activities (%)		
Not elevated	64	67
Elevated	29	27
Missing	5	6
Number comorbid conditions (%)		
None	18	12
1	15	22
2 or 3	31	32
4 or more	36	34
Missing	0	0
Payer (%)†		
Litigation	1	1
Medicaid	5	1
Medicare Part A	1	4
Medicare Part B	14	20
Patient private pay	6	2
Health maintenance organization	25	22
Preferred provider	22	20
Workers' compensation	5	3
Other	11	21
Missing	10	6
Intake functional status (0-100)	50 ± 14 (15-94)	52 ± 13 (18-96)
Intake pain (0-10)	7 ± 2 (1-10)	6 ± 2 (0-10)

\* Values are either percentages (%) or continuous data (mean ± SD; minimum, maximum).  
†  $\chi^2$  significant ( $P < .05$ ).

### Patient Response Classification Method

**Directional Preference** Patients were classified as having a DP at intake if (1) the patient's most distal pain intensity decreased, abolished, or centralized and/or their lumbar range of motion improved in response to repeated end-range move-

ment tests or positional loading strategies,<sup>44</sup> and/or (2) the patient reported a specific preference for activities and movements, such as standing and walking (extension preference) or forward bending and sitting (flexion preference), requiring objective confirmation.<sup>42</sup> If the

initial physical examination findings were inconclusive, the patient might have been judged to have DP based on self-report activity and postural preferences. In this case, DP was considered provisional, and additional testing and further delineation on subsequent visits were required. If patients did not display DP, they were classified as having no-DP. Interrater reliability for identifying a DP for patients whose symptoms centralized has been reported to be strong ( $\kappa = 0.90, P < .001$ ).<sup>36,43</sup> There are no studies describing the reliability of DP classification when patient's symptoms did not centralize.

**Pain Pattern Classification** Intake pain pattern classification had 3 categories: centralization (CEN), noncentralization (non-CEN), and not able to be classified (NC), which have been recommended for routine use<sup>1</sup> and operationally described.<sup>64</sup> Briefly, patients were classified into CEN, non-CEN, or NC subgroups at intake by quantifying changes in pain location observed during a standard physical examination following Mechanical Diagnosis and Treatment assessment methods,<sup>44</sup> without consideration of symptom intensity, by using a body diagram and overlay template. The patient was instructed by the examiner to shade in all areas on the body diagram where she or he was experiencing spinal pains and referred symptoms at the present moment. Body diagrams were completed in standing before and after end range repeated trunk movements and or positioning techniques. The overlay template was placed over the body diagram, which allowed quantification of the anatomical location of pain. Interrater reliability for documenting CEN and non-CEN identified during the physical examination using body diagrams/measurement template classification procedure has been reported to be almost perfect agreement ( $\kappa = 0.96-1.00$ ).<sup>61</sup>

**Patient Evaluation and Treatment** Patient evaluation was standardized. All patients were evaluated at intake using the Mechanical Diagnosis and Therapy assessment method,<sup>44</sup> augmented by ex-

amination tests recommended by recent clinical prediction rules for manipulation<sup>16</sup> and stabilization,<sup>30</sup> and neurological screening (ie, muscle strength tests,<sup>35</sup> light touch for sensation,<sup>45</sup> and deep tendon reflex tests<sup>31</sup>). Patients classified into a directional preference or centralization category were treated with specifically matched exercises and manual techniques.<sup>39-41</sup>

## Outcomes

Two outcomes measures were assessed: pain intensity and patient self-report functional status. Maximal pain intensity reported by the patient during the past 24 hours was assessed using an 11-point numeric pain scale ranging from 0 (no pain) to 10 (worst imaginable pain).<sup>7,32</sup> The 11-point numeric pain scale measure has been reported to be reliable and valid in this population.<sup>7,32</sup>

We quantified the patient's functional status by using a computerized adaptive testing<sup>58</sup> application specific for patients with low back pain.<sup>26,28,58</sup> The lumbar computerized adaptive testing and functional status measure have been described,<sup>26,28</sup> with data supporting adequate reliability, validity, sensitivity to change, responsiveness, and usability.<sup>11,12,26,28</sup> Briefly, items from the Back Pain Functional Scale<sup>53</sup> and other functional status items<sup>26</sup> were cocalibrated into 1 unidimensional scale using item response theory methods,<sup>58</sup> for the purpose of efficiently evaluating a patient's function, by selecting informative items related to the patient's functional status. In contrast to giving a fixed-length survey, a computerized adaptive testing administration selected items from the item bank one at a time, based on an administrative algorithm. The lumbar computerized adaptive testing started by administering the most informative item at median-level difficulty ("Do you or would you have any difficulty at all with any of your usual work, housework, or school activities?"). Patients selected answers to each item, and the computerized adaptive testing estimated the patient's functional status

score with associated standard error. The computerized adaptive testing continued to administer items until a stopping rule was satisfied.

Using computerized adaptive testing to collect outcomes data in routine clinical work is a relatively new concept, but small- and large-scale applications have been described.<sup>11,12,24,25,33,64</sup> The primary benefits of a computerized adaptive test are efficient data collection (ie, reduced respondent burden), with little loss of measurement precision and ability to automatically integrate diverse data sets (eg, an integrated electronic outcomes process with electronic health records).<sup>11,12</sup> The functional status measure generated from computerized adaptive testing ranges from 0 (low functioning) to 100 (high functioning) on a linear metric.

## Risk Adjustment Variables

To provide meaningful clinical interpretations of results of multivariate models, outcomes measures must be adjusted by appropriate independent variables.<sup>24,47,48,50-52</sup> Hence, we used the following independent variables to adjust for case mix of our sample: intake functional status (for the discharge functional status model), intake pain (for the discharge pain model), age (continuous), symptom acuity (calendar days between date of condition onset to date of initial evaluation, grouped as acute [0-20 days], subacute [21-90 days], chronic [greater than 90 days]), surgical history (none, 1 or more), condition complexity (quartile of the number of comorbid conditions, such as cardiac disease, cancer, diabetes mellitus, obesity),<sup>21,49</sup> gender (male, female), fear-avoidance beliefs of physical activities (elevated, not elevated),<sup>27</sup> and payer<sup>46</sup> (fee for service, litigation, Medicaid, Medicare Part A, Medicare Part B, patient private pay, health maintenance organization, preferred provider organization, workers' compensation, or other [includes military]).

## Data Analyses

We calculated prevalence rates 4 ways:



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first, for DP and no-DP; second, for CEN, non-CEN, and NC; third, for patients with DP, prevalence for CEN, non-CEN, and NC; and fourth, replicating the previous 3 sets of prevalence calculations by age group and symptom acuity. Differences in prevalence rates were assessed using chi-square tests of independence. Two ordinary least-squares multivariate linear regression models (1 for discharge functional status and 1 for discharge pain) were used to assess whether, compared to patients who were classified as DP and CEN, being classified as DP/non-CEN, DP/NC, no-DP/non-CEN, or no-DP/NC predicted discharge functional status or pain intensity, while controlling for intake functional status or pain, symptom acuity, age, gender, surgical history, payer, fear, and number of comorbidities. Although being classified as no-DP/CEN seems possible, according to a 2-by-3 design (2 levels of DP and 3 levels of pain pattern), by definition no patients should be classified into this subgroup. Beta coefficients with 95% confidence intervals (CIs) and *t* tests ( $\alpha = .05$ ) were used to test the differences between classifications.

## RESULTS

### Prevalence

OVERALL PREVALENCE OF DP AND CEN was 60% and 41%, respectively (TABLE 2). For those classified as DP, prevalence rates for CEN, non-CEN, and NC were 65%, 27%, and 8%, respectively (TABLE 4). Prevalence rates of DP and CEN decreased as age increased and symptoms became more chronic, and prevalence rates of no-DP and non-CEN increased as age increased and symptoms became more chronic (TABLES 2-5). All differences in prevalence rates were affected by age and acuity (chi-square  $P < .001$ ), except for those classified as DP. Prevalence of pain pattern classification tended to be affected by acuity, but the difference was not significant ( $P = .07$ ).

Classification	Overall	18-44 y	45-65 y	>65 y
DP	60 (56, 64)	74 (68, 80)	64 (59, 72)	31 (23, 39)
No-DP	28 (24, 32)	16 (11, 20)	25 (20, 31)	52 (44, 61)
Missing	12	10	11	17
PPC				
CEN	41 (36, 44)	61 (55, 68)	35 (29, 41)	15 (9, 21)
Non-CEN	33 (29, 37)	22 (16, 27)	40 (34, 47)	40 (31, 48)
NC	15 (12, 18)	7 (4, 10)	15 (10, 19)	29 (22, 37)
Missing	11	10	10	16

*Abbreviations: CEN, centralization; DP, directional preference; NC, could not be classified by PPC; no-DP, no directional preference; non-CEN, noncentralization; PPC, pain pattern classification.*  
\* Values are proportions (percents) of patients or prevalence rates (95% confidence interval).

Classification	Acute	Subacute	Chronic
DP	69 (61, 77)	58 (51, 66)	57 (51, 63)
No-DP	13 (7, 18)	27 (20, 44)	35 (29, 40)
Missing	18	14	8
PPC			
CEN	54 (45, 62)	39 (31, 46)	35 (29, 40)
Non-CEN	22 (15, 29)	31 (24, 38)	39 (34, 45)
NC	7 (3, 12)	16 (11, 22)	19 (14, 23)
Missing	17	14	7

*Abbreviations: CEN, centralization; DP, directional preference; NC, could not be classified by PPC; no-DP, no directional preference; non-CEN, noncentralization; PPC, pain pattern classification.*  
\* Values are proportions (percents) of patients or prevalence rates (95% confidence interval).

PPC	Overall	18-44 y	45-65 y	>65 y
CEN	65 (60, 70)	83 (77, 88)	54 (46, 62)	47 (32, 61)
Non-CEN	27 (23, 32)	13 (8, 18)	35 (27, 42)	42 (27, 57)
NC	8 (5, 10)	4 (1, 8)	11 (6, 17)	11 (2, 21)

*Abbreviations: CEN, centralization; NC, could not be classified by PPC; non-CEN, noncentralization; PPC, pain pattern classification.*  
\* Values are proportions (percents) of patients or prevalence rates (95% confidence interval).

### Predictive Validity

The amount of variance explained ( $R^2$  values) of functional status and pain models was 0.50 and 0.39, respectively. Compared to patients classified as DP/CEN, patients classified as DP/non-

CEN or no-DP/non-CEN reported 7.7 and 11.6 discharge functional status units less, respectively ( $P < .001$ ), and, compared to patients classified as DP/CEN, patients classified as no-DP/non-CEN reported 1.7 discharge pain units

**TABLE 5**

**FOR PATIENTS WITH DIRECTIONAL PREFERENCE, PREVALENCE RATES OF PAIN PATTERN CLASSIFICATION AT INTAKE BY SYMPTOM ACUITY\***

PPC	Acute	Subacute	Chronic
CEN	77 (69, 86)	66 (56, 76)	60 (53, 68)
Non-CEN	18 (10, 26)	23 (15, 32)	31 (24, 38)
NC	5 (1, 9)	11 (4, 17)	9 (5, 13)

Abbreviations: CEN, centralization; NC, could not be classified by PPC; non-CEN, noncentralization; PPC, pain pattern classification.

\* Values are proportions (percents) of patients or prevalence rates (95% confidence interval).

**TABLE 6**

**PREDICTIVE POWER OF DUAL CLASSIFICATION ON FUNCTIONAL STATUS OUTCOMES\***

Classification	$\beta$	95% CI	t Value	P Value
DP/Non-CEN	-7.72	-11.43, -4.01	-4.09	<.001
DP/NC	-0.72	-6.04, 4.59	-0.27	.79
No-DP/Non-CEN	-11.65	-15.41, -7.89	-6.09	<.001
No-DP/NC	-2.02	-6.42, 2.38	-0.90	.37

Abbreviations: CI, confidence interval; DP/CEN, directional preference with centralization; DP/NC, directional preference and not able to be classified by PPC; DP/Non-CEN, directional preference and non-centralizing symptoms; No-DP/NC, no directional preference and not able to be classified by PPC; No-DP/Non-CEN, no directional preference and noncentralizing symptoms; PPC, pain pattern classification.

\* Discharge functional status:  $R^2 = 0.50$ ,  $n = 401$ ,  $F = 15.96$ ,  $P < .001$ . Independent variables were intake FS, symptom acuity, age, gender, surgical history, payer, fear-avoidance of physical activities, and number of comorbidities. The reference group was DP/CEN.

more ( $P < .001$ ), after controlling for important risk adjustment variables (TABLES 6 and 7).

**DISCUSSION**

**T**HE PRIMARY FINDING SUGGESTS that, although CEN and DP are similar, they are not synonymous. In addition, using recommended and standardized operational definitions for judging DP and CEN during the initial examination, we found overall DP and CEN prevalence rates of 60% and 41%, respectively. Consistent with our hypothesis, more patients could be classified by DP than CEN, which is clinically reasonable, considering that DP, compared to CEN, includes additional symptom and/or mechanical responses (eg, changes in pain intensity) reported by patients during movement testing.<sup>40</sup> In addition, DP includes patients whose symptoms may not centralize, yet lumbar range of

motion improved during repeated end range trunk movement tests and/or patients who reported specific aggravating and easing factors confirmed by objective testing. Our prevalence rates for DP and CEN were both higher for patients less than 46 years of age and for patients with acute symptoms (<21 days). Werneke et al<sup>64</sup> have reported that prevalence of DP/CEN for patients with spinal pain was affected by age and acuity, with decreasing prevalence of DP/CEN as age and symptom chronicity increased. We are not aware of other prospective studies that have specifically analyzed DP and CEN prevalence rate data adjusted by age and acuity levels.

Our overall DP prevalence rate of 60% was similar to DP prevalence rates reported in other studies in which patients with low back pain were examined following a similar assessment method and operational definition for DP to that applied in this study.<sup>29,39</sup> For example,

Long et al<sup>39</sup> reported that 74% of individuals with low back pain were classified with DP at intake. We believe our DP prevalence rate was slightly lower because our patient sample was older (mean  $\pm$  SD age,  $50 \pm 18$  years; minimum, 18 years; maximum, 92 years) and had more chronic symptoms (>3 months, 53%) than the group described by Long et al.<sup>39</sup> When different DP assessment methods and operational definitions were examined in other studies, lower DP prevalence rates were reported.<sup>4,19,23</sup> For examples, George et al<sup>19</sup> reported that 21% of patients were classified into a specific exercise subgroup based on DP or CEN criteria, and, of those patients classified into this category, 50% reported a DP without CEN. Hall et al<sup>14</sup> reported that 30.9% of patients with low back pain were classified at intake, based on a clear DP. We believe the lower DP rates reported in these 2 studies, compared to our data, may be partially explained by the authors' operational definition for DP, which included only patients with a subjective postural preference for either trunk flexion or extension activities.

Our results indicate that patients whose symptoms showed directional preference with centralization (DP/CEN) at intake reported better functional status and less pain compared to patients whose symptoms did not centralize and showed no directional preference (no-DP/non-CEN), which partially supports our second hypothesis. Because the minimal important difference for the lumbar computer adaptive testing functional status scores is 5 for individual patients,<sup>28</sup> risk-adjusted group differences of 7.7 for DP/non-CEN and 11.6 for no-DP/non-CEN changes appear to be important change compared to patients classified as DP/CEN. This finding is consistent with many other studies reporting a favorable outcome or prognosis for patients demonstrating a DP whose symptoms were centralizing compared to those patients whose symptoms did not centralize during the initial evaluation.<sup>1,5,6,13,37,60,61,63,64</sup> DP in the presence of non-CEN or NC

**TABLE 7**

**PREDICTIVE POWER OF DUAL CLASSIFICATION ON PAIN OUTCOMES\***

Classification	$\beta$	95% CI	t Value	P Value
DP/Non-CEN	.49	-0.28, 1.25	1.25	.21
DP/NC	.52	-0.60, 1.65	0.91	.36
No-DP/Non-CEN	1.72	0.95, 2.48	4.41	<.001
No-DP/NC	.29	-0.61, 1.19	0.63	.53

*Abbreviations: CI, confidence interval; DP/CEN, directional preference with centralization; DP/NC, directional preference and not able to be classified by PPC; DP/Non-CEN, directional preference and non-centralizing symptoms; No-DP/NC, no directional preference and not able to be classified by PPC; No-DP/Non-CEN, no directional preference and noncentralizing symptoms; PPC, pain pattern classification. \* Discharge pain intensity:  $R^2 = 0.39$ ,  $n = 249$ ,  $F = 6.26$ ,  $P < .001$ . Independent variables were intake pain, symptom acuity, age, gender, surgical history, payer, fear-avoidance of physical activities, and number of comorbidities. The reference group was DP/CEN.*

pattern subgroups was not significant in our function regression model, which did not support our second hypothesis. This was an unexpected finding, especially considering that DP without CEN has gained widespread acceptance by clinicians and researchers as an important patient response classification criterion for the evaluation and treatment of patients with low back pain.<sup>4,8,17,19,23,39-42</sup>

We believe there may be at least 2 reasons that may explain why DP with non-CEN was not an important factor for predicting functional outcome in our model. First, in the absence of centralization, change in pain intensity from movement testing and/or identifying self-reported aggravating and relieving activity patterns from subjective history may be important symptom responses for identifying DP. Although identifying DP based on changes in pain intensity has been recommended, the strength of evidence for assessing changes in pain intensity during the physical examination and within and between treatment visits<sup>14,22,56,57</sup> for determining patients' progress and for guiding future treatment decisions related to function is limited.<sup>8</sup> In addition, establishing directional preference based on patients reporting aggravating or easing activities was recently challenged by Wand et al.<sup>59</sup> The authors reported that observed DP or pattern of aggravating/relieving activities was no different from what would be expected by chance alone and recom-

mended that researchers account for bias and chance when considering the presence of DP.<sup>59</sup> Therefore, it is plausible that DP based on changes in pain intensity or directional patterns may not be an important symptom response to inform prognosis and management related to improving the patient's function compared to DP/CEN, as suggested by our data. There are no other studies investigating the prognostic value and the clinical utility for patient response criteria DP/CEN compared to DP/non-CEN.

Second, the interrater reliability for identifying patients by symptom response DP without CEN is unclear. There are 2 prior studies that examined interrater reliability for DP.<sup>36,65</sup> Kilpikoski et al<sup>36</sup> reported substantial interrater reliability ( $\kappa = 0.90$ ) for identifying DP for patients whose pain was centralizing. However, the authors limited their analyses to DP based on CEN; identifying patients with DP in the absence of CEN was not examined.<sup>36</sup> In another study, Wilson et al<sup>65</sup> reported substantial intertester reliability ( $\kappa = 0.61$ ) for subgroup identification, which was partially based on DP for a specific self-reported activity pattern. However, site of dominant pain either back or leg was the primary criterion to determine initial classification.<sup>65</sup> Further research exploring the reliability of the symptom response for DP in the absence of CEN is recommended.

Interestingly, although DP/non-CEN was not important for explaining func-

tional status at discharge, this was not the case for our pain regression model, which suggested DP for patients whose symptoms centralized or did not centralize at intake facilitated interpretation of pain outcomes at discharge. The averaged risk-adjusted group difference between DP and no-DP subgroups for explaining pain outcome was 1.7 units of pain, which is less than the minimal clinically important difference estimate for individual patients (2 units of pain).<sup>7</sup> Important group differences have been estimated as 40% of minimal clinically important differences for individual patients,<sup>20</sup> so our group difference of 1.7 seems reasonable for an average risk-adjusted important change (ie, 40% of 2.0 is 0.8). Therefore, our data analyzing baseline DP and pain outcomes support claims by others that the presence of DP during the initial evaluation is associated with an early analgesic effect with pain control during the treatment episode.<sup>41</sup> Finally, our pain regression model indicated that DP for patients with NC was not significant for understanding pain outcome at discharge. This appears clinically logical, suggesting that classification by DP is not important for patients who are not experiencing pain prior to repeated movement tests at intake. Only a small number of our patients (8%) were classified into this category (DP/NC).

Papers describing the efficacy for classifying patients by DP without CEN for improving patient outcomes have also been limited. Hall et al<sup>23</sup> classified patients with low back pain into 4 different mechanical pain patterns (patterns 1-4). Patients with back-dominant pain, showing a clear DP as determined by essential questions during the subjective history to identify aggravating and relieving movements, with attention to extension and flexion without assessment of CEN, were classified into pattern 1. Hall et al<sup>23</sup> reported that patients who received treatments guided by baseline classification patterns reported less pain and received fewer treatment visits compared

to patients who did not receive treatment matched to classification. This is the only prior study we are aware of that specifically analyzed DP without CEN as an independent variable and criterion to assist in baseline subgroup identification and outcome assessment. Investigating the generalizability of the findings by Hall et al<sup>23</sup> across different independent samples is required. Two other trials examining the effect of patient response treatment-based classification methods on patient outcomes did not differentiate between DP and CEN classification criteria and outcomes in the analyses, thereby possibly confounding the association between DP/CEN and DP/non-CEN and patient outcomes.<sup>4,39</sup>

Several limitations should be considered when interpreting our results. We did not collect data on patient compliance with home exercises and therapy attendance, which have been reported to be important parameters associated with better treatment outcomes.<sup>12</sup> In addition, our results may not be generalizable to clinicians not specifically trained in Mechanical Diagnosis and Treatment<sup>44</sup> or clinicians who do not objectively judge patient response classification DP and CEN criteria using precise and standardized operational definitions and physical examination testing methods applied in this study. Finally, we did not examine the prevalence of each DP criterion or combinations of DP criteria used by the clinician to judge DP in the absence of CEN, which may affect the clinical interpretation of our findings. For example, we do not know whether the sensitivity and predictive value of DP in the absence of CEN is enhanced when judging DP based solely on the patient's subjective postural/movement preference<sup>4,19</sup> or when DP judgment is based on a patient's movement preference as subsequently confirmed or refuted through objective testing.<sup>42</sup> Future study may be useful to standardize symptom response criteria across classification systems and to reduce practice variation in the assessment of patients with lumbar impairment.

## CONCLUSIONS

**O**UR DATA SUGGEST THAT THE ASSOCIATION between the patient response classification criteria of DP and CEN is complex and not well understood. For example (1) classification by pain pattern at intake appears to be a stronger examination finding compared to classification by DP for interpretation of functional status outcomes; (2) classification by DP for patients who are experiencing pain at intake appears to be an important finding for understanding pain outcomes; and (3) the pain pattern classification NC at intake appears to be associated with favorable functional status and pain outcomes regardless of DP classification. Because of the complex relationships reported in our study between DP and CEN, we recommend that patient responses of DP and CEN should be considered as independent classification variables for analyzing functional status and pain intensity outcomes. Future studies should use a standard assessment and documentation procedure for identifying DP in the presence and absence of CEN to improve patient classification and management strategies for patients with low back pain to enhance self-reported pain and functional status outcomes and reduce practice variation. ●

## KEY POINTS

**FINDINGS:** DP explains pain but not patient self-reported functional status outcomes when pain pattern classification is considered.

**IMPLICATIONS:** The patient response classification criteria regarding DP and CEN should be considered as independent variables for analyzing patient outcomes.

**CAUTION:** Although substantial interrater reliability for identifying DP for patients with low back pain whose symptoms centralize has been reported, interrater reliability for identifying a DP for patients whose symptoms do not centralize during the initial evaluation has not been examined.

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