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Original article

Treatment monitoring as a component of psychologically informed physical therapy: A case series of patients at high risk for persistent low back pain related disability

Jason M. Beneciuk[a,b,*], Lindsay A. Ballengee[c], Steven Z. George[d]

[a] University of Florida, College of Public Health & Health Professions, Department of Physical Therapy, Box 100154, UFHSC, Gainesville, FL 32610-0154, USA
[b] Brooks Rehabilitation Clinical Research Center, 3901 University Blvd. South, Suite 103, Jacksonville, FL 32216, USA
[c] Department of Orthopaedic Surgery, Duke University, 2200 W. Main Street, Suite B-230, Durham, NC 27705, USA
[d] Duke Clinical Research Institute and Department of Orthopaedic Surgery, Duke University, 200 Morris Street, Durham NC 27701, USA

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ABSTRACT

Background: Psychologically Informed Physical Therapy (PIPT) aims to identify individuals at high risk for transitioning to chronicity and merge impairment-focused physical therapy with cognitive behavioral therapy principles. Treatment monitoring is an important part of PIPT and involves identifying changes in clinical measures to inform clinical decision making.
Objectives: The purpose of this case series is to describe treatment monitoring using psychological and physical impairment measures for patients identified as 'high-risk' for persistent low back pain (LBP) related disability.
Design: Secondary analysis of patients (n = 23) identified as 'high-risk' using the STarT Back Tool and enrolled in two-phased, sequential study that evaluated feasibility and generated preliminary PIPT treatment effects for 4-week clinical outcomes.
Method: Physical therapists (n = 5) used psychological [Fear-Avoidance Beliefs Questionnaire (FABQ-PA, FABQ-W), Tampa Scale for Kinesiophobia (TSK-11), Pain Catastrophizing Scale (PCS) and Fear of Daily Activities Questionnaire (FDAQ)] and the Physical Impairment Index (PII) measures for PIPT treatment monitoring. Clinical outcome measures [Numerical Pain Rating Scale (NPRS), Oswestry Disability Index (ODI)] were administered at intake and 4-weeks later. Linear regression models evaluated independent contribution of intake and 4-week changes in psychological measures and PII scores as predictors of 4-week NPRS and ODI scores.
Results: FABQ-PA and PCS changes provided largest contributions to prediction of 4-week ODI scores. Treatment monitoring measures did not explain additional variability in 4-week NPRS scores after baseline scores were considered.
Conclusions: For patients at high risk for persistent LBP psychological measures consistently performed better as treatment monitoring variables compared to physical impairment measures. Treatment monitoring for PIPT with psychological measures provides opportunities to refine prediction of disability outcomes. Findings from this exploratory case series should be interpreted with caution based on its small sample size and lack of statistical power which prohibits definitive conclusions to be made on any of the treatment monitoring measures.

Low back pain (LBP) is a major public health concern because it is highly prevalent and the leading cause of disability worldwide (Global Burden of Disease, 2016a). Global prevalence of LBP has increased by 17.3% from 2005 to 2015 and continues to be a leading cause of global years lived with disability since 1990 (Global Burden of Disease, 2016a; Global Burden of Disease, 2016b). Furthermore, approximately 25% of people consulting primary care providers for an episode of acute LBP will develop chronic pain (Chou and Shekelle, 2010). Psychologically informed physical therapy (PIPT) is a secondary prevention approach for LBP that first aims to identify individuals at high risk for transitioning to chronicity and then provides tailored treatment by merging impairment-focused physical therapy with cognitive behavioral therapy principles as needed to reduce that risk (Main and George, 2011; Keefe et al., 2018). The primary goal of PIPT is to prevent LBP associated disability by emphasizing: (1) identification of individuals who are at high risk for developing chronic LBP based on the presence of

* Corresponding author. University of Florida, College of Public Health & Health Professions, Department of Physical Therapy, Box 100154, UFHSC, Gainesville, FL 32610-0154, USA.
E-mail addresses: beneciuk@phhp.ufl.edu (J.M. Beneciuk), lindsay.ballengee@duke.edu (L.A. Ballengee), steven.george@duke.edu (S.Z. George).

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psychological distress and (2) targeted treatment aimed at psychological factors in conjunction with traditional, impairment-based physical therapy (Main and George, 2011).

The Subgroups for Targeted Treatment (STarT) Back Approach involves patient stratification into low, medium or high-risk groups and providing matched treatment based on their prognostic risk profile (Hay et al., 2008). Implementing the STarT Back Approach has resulted in increased generic health benefit and cost savings in primary care settings (Hill et al., 2011) and improved clinical outcomes in outpatient physical therapy settings (Beneciuk and George, 2015). Risk group stratification is primarily determined by responses to STarT Back Tool (SBT) psychological items with PIPT treatment approaches indicated for patients identified as 'high-risk' (Hill et al., 2008; Main et al., 2012).

Treatment monitoring is an important component of PIPT that considers the intermediary process between treatment received and clinical outcome (Keefe et al., 2018; Hill and Fritz, 2011). For a high-risk patient, treatment monitoring should consist of longitudinal tracking to identify changes in risk status or dynamic aspects of psychological distress or impairment based measures (e.g., range of motion, spinal tenderness) to predict poor outcomes for pain and functional status (Beneciuk et al., 2014; George et al., 2018). Favorable change may indicate which treatment components should continue to be emphasized; while lack of favorable change may suggest modification in specific treatment components are warranted. Treatment monitoring also has potential for improving clinical outcomes through providing opportunities for enhanced communication with patients (Shimokawa et al., 2010; Simon et al., 2012).

Throughout this manuscript, the term '*treatment monitoring*' describes the process of identifying changes in specific psychological or physical impairment measures that occur in conjunction with PIPT treatment provided. Treatment monitoring can be considered a pragmatic, clinically feasible method to inform clinical decision making by identifying potentially relevant treatment mediators (i.e., variables that change as a result of treatment and related to change in outcome of interest) during patient encounters (Hill and Fritz, 2011; Vlaeyen and Morley, 2005; Kazdin, 2007). An example of treatment monitoring for a high-risk patient would be measurement of reduction of psychological distress during graded exposure (Hill and Fritz, 2011) or increased lumbar flexion range of motion and decreased spinal tenderness during manual therapy and exercise.

Treatment monitoring that is feasible to implement during routine clinical practice is an important element to support clinical decision making since previous studies have identified preliminary key mediators (Smeets et al., 2006; Mansell et al., 2017, 2016). For example, Smeets et al. reported catastrophizing and perceived control over pain were mediators for outcomes in chronic low back pain (Smeets et al., 2006). Recent systematic review findings indicate self-efficacy, psychological distress, and pain-related fear to be mediators of pain or disability outcomes for spine related conditions, although it has been acknowledged that these findings are not conclusive and further research is needed in this area (Lee et al., 2015). Recently, Mansell, et al. found changes in pain-related distress and pain intensity to have mediating effects on the relationship between treatment group allocation (i.e., PIPT or current best care) and change in disability outcomes for patients identified as SBT high-risk for persistent LBP related disability. (Mansell et al., 2016).

The purpose of this exploratory case series is to describe a treatment monitoring process during a 4-week episode of PIPT. This case series included a previously validated physical impairment index and selected psychological measures as treatment monitoring variables. This case series intentionally included patients identified as SBT 'high-risk' to distinguish from previous studies in this area that did not account for initial risk status, therefore our limited sample size was not appropriate for formal mediation analyses. The overall goal of this exploratory case series was to provide initial data to inform clinical decision making and provide information for powering future larger studies that would focus on patients identified as SBT high risk.

1. Methods

1.1. Design overview

Patients included in this case series were part of a two-phased, sequential study that evaluated feasibility and generated preliminary PIPT treatment effects for 4-week clinical outcomes (Beneciuk and George, 2015). The second phase of that study is most relevant as it consisted of patient outcome collection from participating clinicians. All clinicians and patients were selected from seven outpatient physical therapy clinics.

1.2. Risk stratified care training

Clinicians randomized to apply risk stratified care attended three training sessions over the course of 4 weeks. Each session was provided by the study authors (JMB, SZG) and lasted between 2 and 4 h. Education content focused on PIPT practice principles (Main and George, 2011) and was developed to reflect clinical protocols that have been used in previous studies (Main, Sowden, Hill, Watson, Hay; Moseley et al., 2004; Louw et al., 2012). The overall objective of this multifactorial education approach was for clinicians to embrace the biopsychosocial model of pain and disability (Pincus et al., 2013). As a component of stratified care education, physical therapists were trained to implement the STarT Back approach for LBP management (Hay et al., 2008; Hill et al., 2011). The STarT Back approach provides an example of stratification based on prognostic risk for persistent LBP related disability that consists of two corresponding components. First, patients are categorized into one of three subgroups (low, medium, or high risk) for persistent LBP related disability using the 9-item STarT Back Screening Tool (SBT) (Hill et al., 2008). Second, targeted treatment pathways are matched to each SBT subgroup such that patients categorized as low risk receive minimal care primarily consisting of reassurance and education while patients categorized as medium risk also received traditional physical therapy approaches that restoring function by targeting physical symptoms (Delitto et al., 2012). For patients categorized as high risk, physical therapy is focused on restoring function using PIPT which consisted of patient-centered communication, patient education (e.g., pain neuroscience, activation philosophy), activity based intervention (graded exercise or graded exposure), physical impairment based intervention (guided by recent clinical practice guidelines) (Beneciuk and George, 2015; Delitto et al., 2012). Those interested in further description of the intervention approach used for high risk patients in this study can refer to the primary study methods (Beneciuk and George, 2015). Specific to this case series, physical therapists providing stratified care for high risk patients were also instructed in treatment monitoring using unidimensional psychological measures (Beneciuk and George, 2015).

1.3. Patient participants

Consecutive patients referred by a physician to physical therapy for LBP were evaluated by participating physical therapists at outpatient clinic locations. Physical therapists recruited and screened all patients with LBP for study eligibility prior to enrollment. Study inclusion criteria consisted of: 1) adults between the ages of 18 and 65 years seeking physical therapy for LBP (defined as having symptoms at T12 or lower, including radiating pain into the buttocks and lower extremity) and 2) the ability to read and speak the English language. Study exclusion criteria consisted of: 1) the presence of systemic involvement related to metastatic or visceral disease; 2) recent spinal fracture; 3) osteoporosis; or 4) pregnancy. All enrolled patients provided informed consent in compliance with the University of Florida Institutional Review Board.

1.4. Demographic and historical information

Study participants completed a standardized questionnaire consisting of items related to age, sex, race, and employment status.

Information involving LBP clinical characteristics (i.e., prior surgery, symptom duration, symptom onset, symptom location, work-related LBP) was also obtained.

1.5. Determining risk status

1.5.1. STarT Back Screening Tool (SBT)

The SBT is a 9-item screening measure used to identify subgroups of patients with LBP based on the presence of modifiable prognostic factors which may be useful in matching patients with targeted interventions (Hill et al., 2008). SBT overall scores (ranging from 0 to 9) and SBT psychosocial subscale scores (ranging from 0 to 5) are determined by summing all positive responses. The SBT then categorizes patients as 'high-risk' (psychosocial subscale scores ≥ 4) in which high levels of psychosocial prognostic factors are present with or without physical factors present, 'medium-risk' (overall score > 3; psychosocial subscale score < 4) in which physical and psychosocial factors are present, but not a high level of psychosocial factors, or 'low-risk' (overall score 0–3) in which few prognostic factors are present (Hay et al., 2008). This case series reports on only those patients that met these eligibility criteria, provided informed consent, and were categorized as SBT 'high-risk'.

1.6. Treatment monitoring measures

Treatment monitoring measures were collected at baseline and 4 weeks later. These measures are described in more detail below:

1.6.1. Fear-Avoidance Beliefs Questionnaire (FABQ-PA, FABQ-W)

Fear-avoidance beliefs specific to LBP were assessed with the FABQ (Waddell et al., 1993). The FABQ consists of a 4-item FABQ physical activity scale (FABQ-PA, potentially ranging from 0 to 24) and a 7-item FABQ work scale (FABQ-W, potentially ranging from 0 to 42), with higher scores indicating higher levels of fear-avoidance beliefs for both FABQ scales. Both FABQ scales have been found to have acceptable reliability (Waddell et al., 1993; Jacob et al., 2001; Pfingsten et al., 2000; Staerkle et al., 2004) and demonstrated internal consistency (Waddell et al., 1993; Staerkle et al., 2004; Kovacs et al., 2006; Swinkels-Meewisse et al., 2006a, 2006b). The FABQ-W has demonstrated predictive validity for disability and work loss in patients with LBP (Staerkle et al., 2004; Fritz and George, 2002; Fritz et al., 2001; George et al., 2003).

1.6.2. Pain Catastrophizing Scale (PCS)

The PCS was used to assess the degree of catastrophic cognitions due to LBP (Sullivan et al., 1995). Pain catastrophizing has been broadly defined as an exaggerated negative orientation towards actual or anticipated pain experiences (Sullivan et al., 1995). The PCS is a 13-item questionnaire with a potential range of 0–52, with higher scores indicating higher levels of pain catastrophizing. The PCS has been found to have good test-retest reliability (Sullivan et al., 1995) and internal consistency (Crombez et al., 1998, 1999; Osman et al., 2000). The PCS has also been found to demonstrate several different types of validity (Sullivan et al., 1995; Crombez et al., 1998, 1999; Osman et al., 2000).

1.6.3. Tampa Scale of Kinesiophobia (TSK-11)

The TSK-11 was used to assess the degree of fear of movement and injury or re-injury in individuals with LBP (Woby et al., 2005). The TSK-11 is an 11-item questionnaire with a potential range of 11–44, with higher scores indicating greater fear of movement and injury or re-injury due to pain. The TSK-11 has been found to have good test-retest reliability and internal consistency (Woby et al., 2005). Predictive and concurrent validity have also been reported for the TSK-11 (Woby et al., 2005).

1.6.4. Fear of Daily Activities Questionnaire (FDAQ)

The FDAQ was used to quantify fear of 'specific' activities commonly reported by patients experiencing LBP (George et al., 2009). The FDAQ is a 10-item scale with a total range of 0–100, with higher scores indicating higher fear of specific activities. Inclusion of the FDAQ has been shown to improve subgrouping methods for patients with LBP (Beneciuk et al., 2012).

1.6.5. Physical Impairment Index (PII)

The PII was administered by a physical therapist to quantify physical impairment due to LBP (Waddell et al., 1992). The PII consists of 7 different physical examination procedures: 1) lumbar flexion range of motion (ROM); 2) lumbar extension ROM; 3) lumbar lateral flexion ROM; 4) passive straight leg raise ROM; 5) bilateral active straight leg raise; 6) active sit-up; and 7) assessment of spinal tenderness with each procedure scored as a negative (0) or positive (1) for presence of impairment. The PII has a total range of 0–7, with higher scores indicating higher levels of physical impairment due to LBP. Good or excellent reliability has been reported for individual PII items and convergent validity has been supported for LBP disability (Waddell et al., 1992; Fritz and Piva, 2003). Overall PII scores have been reported to be more responsive to change compared to individual test items, with a 1-point change representing minimal detectable change over four-weeks of physical therapy (Fritz and Piva, 2003).

1.7. Clinical outcome measures

Clinical outcome measures were collected at intake and 4-weeks later and are described in more detail below.

1.7.1. Numerical Pain Rating Scale (NPRS)

Pain intensity was rated using a NPRS, ranging from "0" (no pain) to "10" (worst pain imaginable). Participants were asked to rate their current pain intensity, as well as their best and worst level of pain intensity over the past 24 h. These three pain ratings were averaged and used as the NPRS variable in this study (Jensen et al., 1996). The NPRS has been found to have sound psychometric properties (Jensen et al., 1996, 1999; Bolton, 1999) with a minimal clinically important difference reported to be 2 points (Childs et al., 2005).

1.7.2. Modified Oswestry Disability Index (ODI)

LBP-related disability was assessed with the ODI, which has 10 items that assesses how LBP affects common daily activities (Fritz and Irrgang, 2001; Hudson-Cook et al., 1989). The ODI has a range of 0% "no disability due to LBP" to 100% "completely disabled due to LBP", with higher scores indicating higher disability from LBP. The ODI has been found to have sound psychometric properties (Fritz and Irrgang, 2001; Fairbank and Pynsent, 2000; Roland and Fairbank, 2000) with a minimal clinically important difference reported to be 10 percentage points (Ostelo et al., 2008).

1.8. Data analysis

All statistical analyses were performed using SPSS version 24.0 (SPSS Inc., Chicago, Illinois). Descriptive statistics were used to provide a summary of data with means and standard deviations calculated for all baseline continuous variables and frequency counts with percentages for categorical variables.

1.8.1. Univariate associations between treatment monitoring and clinical outcomes measures

Bivariate associations using Pearson *r* correlation coefficients were calculated for 4 week changes in treatment monitoring (FABQ-PA, FABQ-W, PCS, TSK-11, FDAQ, and PII) and clinical outcome (NPRS and ODI) measure scores to assess which observed changes were associated with clinical outcomes. Magnitude of Pearson *r* correlation coefficients were interpreted as "little to no relationship" (0.00–0.25), "fair" (0.25–0.50), "moderate to good" (0.50–0.75), and "good to excellent" (above 0.75). (Portney and Watkins, 2009).

1.8.2. Multivariate treatment monitoring associations with four week clinical outcomes

Separate simple linear regression models were used to evaluate independent associations for intake and 4-week changes in treatment monitoring (FABQ-PA, FABQ-W, PCS, TSK-11, FDAQ, and PII) measure scores with NPRS and ODI scores at 4-weeks. Two separate models were created for each treatment monitoring measure. Model 1 accounted for intake dependent variable scores (i.e., NPRS or ODI depending upon the outcome of interest) and intake psychological measure or PII score (depending upon treatment monitoring variable of interest). Model 2 added 4-week psychological measure or PII change scores to Model 1.

2. Results

Twenty three participants out of the original 70 (32.9%) that received PIPT were categorized as 'high risk' and included in this case series (Table 1). Duration of symptoms for this sample was categorized into three groups (14 days or less [n = 1, 4.3%]; 15–90 days [n = 10, 43.5%]; and 91 days or longer [n = 12, 52.2%]). Symptom duration was not associated with NPRS or ODI outcome scores at 4 weeks (P > .05) and therefore was not included as a covariate in regression models.

2.1. Univariate correlates of treatment monitoring and clinical outcome measures

Pearson correlation coefficients are reported in Table 2. Moderate to good associations (r = 0.574 to 0.768, P < .05) were observed between psychological measure 4 week change scores. Little associations were observed between psychological measures and PII 4 week change scores (r = 0.028 to 0.185; P > .05). Moderate to good associations (r = 0.455 to 0.697, P < .05) were observed between 4 week changes in ODI scores and changes in psychological measures while little associations (r = 0.010 to 0.260; P > .05) between 4 week changes in NPRS scores and changes in treatment monitoring measures were observed.

Table 1
Baseline characteristics of study sample (n = 23).

Variable	Value
Age (years)	43.7 (12.5)
Sex, female (n) (%)	15 (65.2%)
Race (n) (%)	
Caucasian	16 (69.6%)
Black or African American	5 (21.7%)
Other	2 (8.7%)
Employment status	
Employed	17 (73.9%)
Unemployed	4 (17.4%)
Retired	2 (8.7%)
Work related LBP (yes)	1 (4.3%)
Symptom duration	
≤14 days	1 (4.3%)
15–90 days	10 (43.5%)
≥91 days	12 (52.2%)
Psychological Measures	
FABQ-PA (potential range, 0 to 24)	17.6 (5.1)
FABQ-W (potential range, 0 to 42)	23.4 (10.7)
PCS (potential range, 0 to 52)	30.3 (11.1)
TSK-11 (potential range, 11 to 44)	30.3 (7.0)
FDAQ (potential range, 0 to 100)	56.5 (20.6)
Clinical Measures	
NPRS (potential range, 0 to 10)	6.0 (2.0)
ODI (potential range, 0 to 100)	44.6 (15.4)
PII (potential range, 0 to 7)	4.3 (1.6)

Values are reported as mean point estimates (standard deviation) for continuous variables and frequency counts (percentage) for categorical variables. LBP = low back pain; FABQ-PA = Fear Avoidance Beliefs Questionnaire (physical activity scale); FABQ-W = Fear Avoidance Beliefs Questionnaire (work scale); PCS = Pain Catastrophizing Scale; TSK-11 = Tampa Scale for Kinesiophobia (11 item version); FDAQ = Fear of Daily Activities Questionnaire; NPRS = Numerical Pain Rating Scale; ODI = Oswestry Disability Index; PII = Physical Impairment Index.

Table 2
Relationship between psychological and clinical measure change scores at 4 weeks.

	FABQ-W	PCS	TSK-11	FDAQ	PII	NPRS	ODI
FABQ-PA	.637**	.694**	.699**	.592**	.168	.010	.697**
FABQ-W		.616**	.652**	.715**	.028	-.021	.219
PCS			.749**	.574**	.169	.184	.651**
TSK-11				.768**	.185	.220	.455*
FDAQ					.065	.260	.204
PII						.258	.250
NPRS							.368

**P < .01; *P < .05. FABQ-PA = Fear Avoidance Beliefs Questionnaire (physical activity scale); FABQ-W = Fear Avoidance Beliefs Questionnaire (work scale); PCS = Pain Catastrophizing Scale; TSK-11 = Tampa Scale for Kinesiophobia (11 item version); FDAQ = Fear of Daily Activities Questionnaire; NPRS = Numerical Pain Rating Scale; ODI = Oswestry Disability Index; PII = Physical Impairment Index.

2.2. Treatment monitoring multivariate association with 4 week clinical outcomes

2.2.1. Pain intensity

Intake NPRS and treatment monitoring measures explained a large amount of variability in 4-week NPRS scores (range: 45.6%–47.7%, P < .05) (Table 3 – Model 1). The addition of 4-week change in treatment monitoring measures did not explain additional variability in 4-week NPRS scores (Table 3 – Change from Model 1 to Model 2).

2.2.2. Disability

Intake ODI and treatment monitoring measures explained a large amount of variability in 4-week ODI scores (range: 30.6%–38.0%) (Table 4 – Model 1). However, the 4-week change in treatment monitoring added to these regression models. Specifically, the addition of 4-week FABQ-PA (Δ37.0%), FABQ-W (Δ 20.0%), PCS (Δ 27.1%), TSK-11 (Δ 16.3%), and FDAQ (Δ 15.2%) change scores explained an additional amount of variability (P < .05) in 4-week ODI scores (Table 4 – Change from Model 1 to Model 2).

3. Discussion

This exploratory case series used psychological and physical impairment measures as treatment monitoring variables for patients with LBP that were categorized as SBT high risk. Our primary finding was that for LBP related disability, psychological measures were consistently better for treatment monitoring in comparison to the PII. Another important finding was that none of the treatment monitoring measures improved prediction of 4-week pain intensity outcomes better than baseline pain intensity scores. Collectively, these results indicate that for patients with LBP categorized as SBT high-risk, treatment monitoring (i.e. 4-week change from baseline) with psychological measures can be used to refine prediction of disability outcomes, but not for pain intensity. These results also suggest that there may be a limited treatment monitoring role for physical impairment measures in this patient population.

The finding that in this small sample of patients psychological measures were better at treatment monitoring in comparison to a PII is not surprising. We intentionally used a previously validated physical impairment index that incorporated different individual measures and has been correlated with recovery of function in patients with LBP (Waddell et al., 1992; Fritz and Piva, 2003; Fritz and Irrgang, 2001). However, this composite measure did not contribute to regression models in this small cohort. Previous studies have indicated psychological factors to be stronger predictors for LBP outcomes when compared

Table 3
Prediction of pain intensity (NPRS) at 4 weeks.

	Model 1	Model 2	Change from Model 1 to Model 2
Treatment Monitoring Measure	Intake NPRS + Intake Score	Model 1 + Change Score at 4 Weeks	Additional Variance Explained by Change Score at 4 Weeks
FABQ-PA	$\%R^2 = 45.7$	$\%R^2 = 46.3$	$\%R^2 = 0.5$
	Adjusted $\%R^2 = 39.7$	Adjusted $\%R^2 = 36.8$	P = .686
FABQ-W	$\%R^2 = 46.2$	$\%R^2 = 46.6$	$\%R^2 = 0.4$
	Adjusted $\%R^2 = 40.2$	Adjusted $\%R^2 = 37.1$	P = .723
PCS	$\%R^2 = 45.7$	$\%R^2 = 49.9$	$\%R^2 = 4.2$
	Adjusted $\%R^2 = 39.6$	Adjusted $\%R^2 = 41.1$	P = .248
TSK-11	$\%R^2 = 45.7$	$\%R^2 = 52.2$	$\%R^2 = 6.6$
	Adjusted $\%R^2 = 39.6$	Adjusted $\%R^2 = 43.8$	P = .145
FDAQ	$\%R^2 = 45.6$	$\%R^2 = 53.5$	$\%R^2 = 7.9$
	Adjusted $\%R^2 = 39.6$	Adjusted $\%R^2 = 45.3$	P = .107
PII	$\%R^2 = 47.7$	$\%R^2 = 52.8$	$\%R^2 = 5.1$
	Adjusted $\%R^2 = 41.1$	Adjusted $\%R^2 = 43.4$	P = .221

FABQ-PA = Fear Avoidance Beliefs Questionnaire (physical activity scale); FABQ-W = Fear Avoidance Beliefs Questionnaire (work scale); PCS = Pain Catastrophizing Scale; TSK-11 = Tampa Scale for Kinesiophobia (11 item version); FDAQ = Fear of Daily Activities Questionnaire; NPRS = Numerical Pain Rating Scale; PII = Physical Impairment Index.

to physical impairment measures (Burton et al., 1995; George et al., 2006). This exploratory case series adds to the existing literature by considering the PII for treatment monitoring in high risk patients when in previous studies only baseline values were used without consideration of risk status. However, this does not necessarily exclude measuring physical impairment as part of treatment monitoring as this sample was too small to make definitive conclusions.

Furthermore, this case series suggests that general psychological measures may be appropriate for treatment monitoring for high risk patients when compared to measures that elicit more specific beliefs. In this case series, the FDAQ was included as a patient specific measure and it contributed the smallest amount of variance to disability outcomes. Therefore, there may be limited value in capturing and monitoring fear of patient-specific activities over existing general psychological measures. These results align with previous research that has examined specific fear-avoidance activity monitoring to predict disability outcomes (Pincus et al., 2010). For example, the Photograph Series of Daily Activities (PHODA) has been found to reliably detect changes over time in pain-related fear of patients with chronic LBP, however not able to identify patients who are likely to improve according to other pain-related fear measures such as the FABQ and TSK (Oliveira et al., 2018).

A primary limitation of this case series was the small sample size of 23 high risk patients with LBP. When focusing on SBT high risk patients, a smaller sample is inevitable as three separate outpatient physical therapy cohorts in the United States have indicated the prevalence of high risk patients ranged from 20 to 30% of LBP episodes (Beneciuk and George, 2015; Fritz et al., 2011; Beneciuk et al., 2013). There are several limitations related to the sample size including prohibiting use of more sophisticated statistical models for analysis (e.g., latent growth modelling) and the statistical estimates we provided lack precision. Interestingly, there does not appear to be a major issue with statistical power due to sample size. The regression models were generally able to detect changes of 10% or more, which suggests the treatment monitoring variables identified in this case series may potentially have clinical relevance. However, there are inherent limits with samples this small as it limits the type of statistical models that can be used and estimates will be imprecise. Despite this limitation these data can be used to adequately power larger studies focused on SBT high risk patients.

Additional limitations include not administering psychological or physical impairment measures to low or medium risk patients with LBP. Having these additional measures would have allowed comparison of treatment monitoring potential in different SBT risk categories. Finally, we may have obtained more valuable information if treatment monitoring measures were administered during additional time points during the episode of care. If treatment-monitoring measures were administered weekly, for example, we may have been able to obtain higher granularity data or been able to detect whether linear changes in pain associated psychological distress had occurred.

This case series provides several directions for future research. First, the results suggest there is a role for exploring different psychological measures such as self-efficacy for improved treatment monitoring in predicting pain intensity outcomes. Other studies have found promising results by capturing self-efficacy as a significant predictor of health

Table 4
Prediction of disability (ODI) at 4 weeks.

	Model 1	Model 2	Change from Model 1 to Model 2
Treatment Monitoring Measure	Intake ODI + Intake Score	Model 1 + Change Score at 4 Weeks	Additional Variance Explained by Change Score at 4 Weeks
FABQ-PA	$\%R^2 = 30.6$	$\%R^2 = 67.6$	$\%R^2 = 37.0$
	Adjusted $\%R^2 = 22.9$	Adjusted $\%R^2 = 61.8$	P < .001
FABQ-W	$\%R^2 = 38.0$	$\%R^2 = 58.0$	$\%R^2 = 20.0$
	Adjusted $\%R^2 = 31.1$	Adjusted $\%R^2 = 50.6$	P = .011
PCS	$\%R^2 = 31.7$	$\%R^2 = 58.9$	$\%R^2 = 27.1$
	Adjusted $\%R^2 = 24.1$	Adjusted $\%R^2 = 51.6$	P = .004
TSK-11	$\%R^2 = 31.8$	$\%R^2 = 48.1$	$\%R^2 = 16.3$
	Adjusted $\%R^2 = 24.3$	Adjusted $\%R^2 = 39.0$	P = .034
FDAQ	$\%R^2 = 31.3$	$\%R^2 = 46.5$	$\%R^2 = 15.2$
	Adjusted $\%R^2 = 23.7$	Adjusted $\%R^2 = 37.1$	P = .042
PII	$\%R^2 = 31.4$	$\%R^2 = 39.9$	$\%R^2 = 8.5$
	Adjusted $\%R^2 = 22.9$	Adjusted $\%R^2 = 27.9$	P = .165

FABQ-PA = Fear Avoidance Beliefs Questionnaire (physical activity scale); FABQ-W = Fear Avoidance Beliefs Questionnaire (work scale); PCS = Pain Catastrophizing Scale; TSK-11 = Tampa Scale for Kinesiophobia (11 item version); FDAQ = Fear of Daily Activities Questionnaire; ODI = Oswestry Disability Index; PII = Physical Impairment Index.

related quality of life among patients with chronic LBP (Glattacker et al., 2018). Additionally, higher self-efficacy has been associated with a protective effect for severity of pain symptoms in patients with chronic pain (Jackson et al., 2014). Therefore, self-efficacy may be a useful treatment-monitoring variable for future pain intensity and disability outcomes, but to the best of our knowledge, it has not been investigated as such in high-risk patients.

Another direction for future research would be to compare whether use of composite psychological measures (e.g., STarT Back Tool, Örebro Musculoskeletal Pain Screening Questionnaire, and OSPRO Yellow Flag Assessment Tool) (Hill et al., 2008; Linton et al., 2011; Lentz et al., 2016) can be used to enhance treatment monitoring as previous studies have found changes in these measures to improve outcome prediction for disability outcomes in cohort studies (Beneciuk et al., 2013, 2014; George et al., 2018). Future research could compare these composite measures with unidimensional measures to determine which are most appropriate for treatment monitoring in high-risk patients.

Finally, future research should consider how other non-psychological measures such as socioeconomic status (Beneciuk et al., 2017) and race (Katzan et al., 2018) impact treatment monitoring to provide further insight to the unexplained variance in pain and disability outcomes. In this case series, we included an index consisting of 8 different components including lumbar flexion, extension, pelvic flexion, lateral flexion, straight leg raising, spinal tenderness, bilateral active straight leg raise, and sit-up. However, additional composite impairment or performance based measures such as postural control or the ability to perform a functional task may provide more useful information that is also feasible to assess during routine clinical encounters. For example, improvement in trunk postural control among patients with low back pain has been found to be a significant predictor for LBP related pain and disability outcomes (Shahvarpour et al., 2018). Moreover, Timed Up and Go test scores have been found to be associated with pain, disability and lumbar mobility measures (Gautschi et al., 2016; Coyle et al., 2017).

4. Conclusion

For high-risk patients with low back pain, psychological measures performed better as treatment monitoring tools for disability outcomes when compared to a physical impairment index. Psychological measures were not better predictors of change in pain intensity over baseline pain intensity scores. Findings from this exploratory case series should be interpreted with caution based on small sample size and lack of statistical power which prohibits definitive conclusions to be made on any of the treatment monitoring measures. Future research is needed to determine whether additional psychological factors (e.g. self-efficacy) improve prediction of pain and disability outcomes in high-risk patients.

Conflicts of interest

The authors declare no conflicts of interest.

Ethical approval

All enrolled patients provided informed consent in compliance with the University of Florida Institutional Review Board.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2019.03.004.

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