ORIGINAL RESEARCH

A Cluster Analysis of Initial Primary Care Orders for Patients with Acute Low Back Pain

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Purpose: **Primary care physicians (PCPs) often face a complex intersection of patient expectations, evidence, and policy that influences their care recommendations for acute low back pain (aLBP). The purpose of this study was to elucidate patterns of PCP orders for patients with aLBP, identify the most common patterns, and describe patient clinical and demographic characteristics associated with patterns of aLBP care.**

Methods: **This prospective cohort study included 9574 aLBP patients presenting to 1 of 77 primary care practices in 4 geographic locations in the United States. We performed a cluster analysis of PCP orders extracted from electronic health records within the first 21 days of an initial visit for aLBP.**

Results: **1401 (15%) patients did not receive a PCP order related to back pain within the first 21 days of their initial visit. These patients predominantly had aLBP without leg pain, less back-related disability, and were at low-risk for persistent disability. Of the remaining 8146 patients, we found 4 distinct order patterns: combined nonpharmacologic and first-line medication (44%); second-line medication (39%); imaging (10%); and specialty referral (7%). Among all patients, 29% received solely 1 order from their PCP. PCPs more often combined different guideline concordant and discordant orders. Patients with higher self-reported disability and psychological distress were more likely to receive guideline discordant care.**

Conclusion: **Guideline discordant orders such as steroids and NSAIDS are often combined with guideline recommended orders such as physical therapy. Further defining patient, clinician, and health care setting characteristics associated with discordant care would inform targeted efforts for deimplementation initiatives. (J Am Board Fam Med 2023;36:986–995.)**

Keywords: **Acute Pain, Low Back Pain, Musculoskeletal Pain, Primary Health Care, Prospective Studies**

Introduction

Chronic low back pain (cLBP) is a leading cause of disability and health care utilization.[1,2] Effective initial management of acute low back pain (aLBP) may prevent cLBP[3,4] and downstream health care costs.[5,6] Primary care physicians (PCPs) are often the initial clinician for patients with aLBP;[7] back pain is the second most common symptomatic reason for a primary care visit.[8] Thus, PCPs are uniquely positioned to

This article was externally peer reviewed.

Submitted 28 March 2023; revised 31 May 2023; 13 June 2023; accepted 20 June 2023.

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Funding: The TARGET Trial and Inception Cohort were funded by the Patient Centered Outcomes Research Institute (PCORI contract # NCT02647658). ClinicalTrials.gov Identifier: NCT02647658.

Conflict of interest: The authors have no conflicts of interest to declare.

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influence the trajectory of patients with aLBP in terms of recovery and subsequent health care utilization.

Clinical practice guidelines by the American College of Physicians recommend nonpharmacologic approaches such as massage and spinal manipulation for initial management for aLBP (recommendation strength: strong).[9] Medications such as nonsteroidal anti-inflammatories (NSAIDs) and muscle relaxants are considered a first-line treatment for aLBP only if the patient expresses preference for a medication (recommendation strength: strong).[9,10] Pharmacologic treatments such as opioids are associated with a greater risk profile and are not recommended for aLBP. In the absence of progressive neurologic symptoms or other red flags, radiographic and magnetic resonance imaging should be delayed until after a trial of nonpharmacologic and/or first-line pharmacologic treatment. While there is no guideline recommendation for when to refer to a medical specialist, this referral is often associated with utilization of invasive procedures (eg, epidural injections) that are not recommended.[11]

Although the practice patterns of PCPs for low back pain have been described previously,[11–13] few studies capture the complexity of PCP orders relative to current clinical practice guidelines. More commonly, previous literature focuses on single interventions rather than how treatments are combined in real-world practice. For example, imaging,[14,15] opioid prescribing,[16] physical therapy (PT),[17] and other nonpharmacologic treatments[18] have been compared against themselves in primary care settings using claims databases. However, claims analyses typically examine new episodes of care which are likely a heterogeneous group of acute, subacute, and chronic back pain. Moreover, claims data does not provide a comprehensive view of PCP recommendations. PCPs may recommend several concurrent treatments (eg, opioid prescription and order for PT), diagnostic tests, or consultations (eg, a radiograph and referral to a specialist) and the patient self-selects the services they use. Last, claims data provide limited insight on patient-related clinical characteristics that may be influencing PCP decision making. Given the high prevalence of back pain in primary care settings, there is a need to describe the combinations of treatments PCPs recommend to patients with aLBP.

Recently, in a large sample of patients with aLBP initially seen in primary care, we found associations between the amount of guideline discordant treatments (eg, opioids) or procedures (eg, imaging) provided and the risk of developing cLBP.[19] However, we did not explore combinations of orders that may be both guideline concordant and discordant simultaneously. Clarifying the degree to which nonconcordant treatments are recommended as the sole intervention or in combination with other treatments is important to understanding the degree to which current clinical practice guidelines have been implemented in routine primary care practice. Moreover, identifying any distinguishing characteristics in populations receiving certain forms of care will guide implementation efforts to improve care. The aims of this study were to: 1) describe guideline concordant and discordant health care orders initiated by PCPs for patients with aLBP, 2) identify similar patterns of orders, and 3) describe patient clinical and demographic characteristics associated with order patterns.

Methods

Study Design

The Targeted Interventions to Prevent Chronic Low Back Pain in High-Risk Patients (TARGET) protocol and primary results articles have been published elsewhere.[19–21] Briefly, 9547 aLBP patients presenting to 1 of 77 primary care practices in 4 geographic locations (Baltimore, MD; Boston, MA; Pittsburgh, PA; Salt Lake City, UT) were screened using the STarT Back Tool[22] and stratified as being at low, moderate, or high risk of developing chronic low back pain. Regardless of risk stratification, all patients were followed over the next twelve months as part of the inception cohort study. High-risk patients (n = 2300) were additionally enrolled in a pragmatic, multi-site, randomized controlled trial that compared usual care to referral to a stratified approach to care using psychologically informed physical therapy (ie, PT that is combined with cognitive behavioral strategies). Patients were enrolled between May 2016 and June 2018. Four institutional review boards approved the trial. The current study included all patients enrolled in the trial and cohort.

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Sample

Patients were eligible for enrollment if they were 18 years of age or older and presented to the clinic with a primary complaint of acute axial LBP or LBP with associated leg pain as determined by ICD-9 or ICD-10-CM diagnosis codes. Patients with the signs or symptoms associated with serious pathology (eg, vertebral fracture, cancer) were excluded. To ensure acuity of low back pain, a 2-item acute/chronic LBP screening questionnaire was created by adapting the National Institute of Health Research Standards definition for chronic LBP.[23] Patients were asked: (1) how long has your low back pain interfered with your ability to do regular daily activities, and, (2) in the last 6 months, how often has low back pain interfered with your ability to do regular activities. If the patient answered "more than 3 months" for the first question, and "half or more than half the days" for the second question, they were considered chronic and excluded from the study.

Data Collection

Primary care orders and patient characteristics were extracted from their respective field in the patient's electronic medical record. Clinical characteristics were extracted from the electronic medical record except for disability and risk stratification which were collected at index visit.

Primary Care Orders

Initial primary care orders were defined as occurring within the first 21 days of an index visit. Orders were categorized into 5 main groups, described below. A detailed breakdown of orders (eg, medications included as steroids, pain management clinicians) is provided in Appendix A.

Non-Pharmacologic

Behavioral health (eg, psychology, psychiatry), chiropractic, mind-body therapies (eg, acupuncture, massage), pain management (eg, pain clinic, physical medicine and rehabilitation), PT, social work, wellness coaching.

First-Line Pharmacologic. Acetaminophen, muscle relaxant, NSAID, and topical NSAID.

Second-Line Pharmacologic. Antidepressant, benzodiazepine, opioid, steroid.

Specialty Referral. Neurology, spine/orthopedic surgery.

Imaging. Computed tomography (CT), magnetic resonance imaging (MRI), or plain radiography (radiograph).

Patient and Clinical Characteristics

Patient and clinical characteristics are described as follows:

Patient Characteristics

Demographics, health insurance (commercial, Medicare, Medicaid and self-pay/other), smoking status (yes/no), body mass index, geographic location of the clinics.

Clinical Characteristics

Back pain diagnosis (axial back pain vs back and leg pain), self-reported LBP functional disability, and risk stratification. Back pain diagnosis was identified via ICD-9 or ICD-10 diagnostic codes present at the index encounter. Self-reported LBP functional disability was measured using the Oswestry Disability Index (ODI),[24] a self-report scale ranging from 0 to 100 with lower scores indicating less disability. Risk stratification was assessed using the Keele STarT Back Tool[22] which assigns a risk of developing cLBP based on patient response to 4 symptom-based and 5 psychological-based items. Scores range from 0 to 9. Patients are characterized as low-risk (total score $\leq$3), medium-risk (total score $\geq$4 and psychological score $\leq$3), or high risk (total score $\geq$4 and psychological score $\geq$4). https://startback.hfac.keele.ac.uk/training/resources/startback-online/.

Analysis

Individual PCP orders and common combinations of orders relevant to low back pain guidelines were examined and are described as frequencies.

Next, a cluster analysis was used to identify distinct groups of patients based on patterns or similarities of particular variables of interest. In this analysis, different types of PCP orders were the variables used to cluster patients. When performing a cluster analysis on a large data set with dichotomous variables (ie, received an order or did not), halving the data into a "training" set and "validation" set can guide the interpretation of the clusters.[25] The "training" set is first analyzed and used to independently determine the number of clusters. The "validation" set is then analyzed using the same clustering method and number of clusters

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from the training set. In this analysis, comparisons of order frequencies as well as clinical and demographic data of the participants in each cluster were examined to evaluate similarity between the clusters from each data set.

Patients who received no orders within the first 21 days were extracted as a separate group leaving those who had at least 1 early primary care order within 21 days of index visit included in the cluster analysis. These patients were split into 2 equal samples using simple random sampling. One half of the data, the "training" dataset, was used to determine the number of clusters. The clustering method was average linkage hierarchical agglomerative clustering and the Jaccard index was used as a measure of distance between patients.[25] The research team reviewed the different models of clusters with the aim of identifying the most parsimonious model with robust numbers per cluster and distinct order patterns among clusters. Once the number of clusters was selected, the other half of the data were used to validate the original clusters.

Clusters were named according to the predominant category (eg, Non-Pharmacological & first-Line Pharmacological) of PCP orders within the cluster. Categories of PCP orders are presented as frequencies within each cluster. The categories were broken down into specific types of orders within each cluster. In addition, common combinations of individual orders in the clusters are described as frequencies. Finally, we compared patient and clinical characteristics among clusters in the training and validation sets to determine if characteristics were associated with clusters. Patient, clinician, and clinical characteristics within each cluster are described as means or frequencies. Analysis was performed in SAS version 9.4.

Results

Of the full sample (9574), 1401 (15%) patients received no PCP order within the first 21 days (Table 1). These patients were predominantly stratified as low-risk (60%), had axial back pain only (89%), and low disability (mean ODI = 23). In the remaining 8146 patients, PCPs solely placed 1 order in 29% of initial visits. When comparing solely nonpharmacologic versus pharmacologic orders, 8% of patients received only nonpharmacologic orders whereas 33% received only pharmacologic (first or second line) orders. There was wide variability in the orders made by PCPs and their concordance with the guidelines. When considering guideline concordant care, 34% of patients received an order for PT and, of them, 11% got an additional NSAID order and 13% received an order for a muscle relaxant. When considering orders that were partially concordant with the guidelines, 13% of patients received a combination of a concordant nonpharmacologic order with a nonconcordant second-line pharmacologic order. However, 14% of patients received solely nonconcordant second-line pharmacologic (8%), imaging (4%), or specialty (2%) orders.

Table 1. Primary Care Physician Orders for 9574 Patients with Acute Low Back Pain Within the First 21 Days of Initial Encounter

	Total (n = 9547)
PCP Orders	
No order	1,401 (15%)
One order	2,780 (29%)
Two orders	2,743 (29%)
Three orders	1,702 (18%)
Non-pharmacologic only	729 (8%)
Pharmacologic only	3,124 (33%)
Multiple pharmacologic	3,400 (36%)
Concordant with Guidelines *	
Non-pharmacologic	3,390 (36%)
Physical therapy	3,321 (34%)
Physical therapy + NSAID	1,057 (11%)
Physical therapy + Muscle relaxant	1,247 (13%)
Partially Concordant with Guidelines*	
Non-pharmacologic + 2nd Line Pharm	1,267 (13%)
Physical therapy + Steroid	790 (8%)
Physical therapy + Opioid	502 (5%)
Physical therapy + Radiograph	721 (8%)
Non-concordant with Guidelines*	
Opioid	1,706 (18%)
Opioid + Muscle relaxant	742 (8%)
Opioid + NSAID	397 (4%)
Steroid	2,356 (25%)
Steroid + Muscle relaxant	1,181 (12%)
Steroid + NSAID	473 (5%)
MRI or Radiograph	2,238 (23%)
Solely 2nd Line Pharmacologic, Imaging, or Specialty	1,306 (14%)

Notes. All values are n (%) where n is the number of patients who received the order.
*Rows are not mutually exclusive (i.e., patients who received physical therapy + NSAID are also included in the physical therapy row) unless otherwise stated.
Abbreviations: NSAID, non-steroidal anti-inflammatory drugs; PCP, primary care physicians.

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Table 2. Cluster Analysis of Primary Care Physician Orders Within the First 21 Days from Initial Visit in 4073 Patients with Acute Low Back Pain

	Non-Pharm & 1st Line Pharm N = 1810	2nd Line Pharm N = 1470	Imaging N = 525	Specialty N = 268
Non-Pharmacologic	962 (53)	494 (34)	209 (40)	42 (16)
1st Line Pharmacologic	1,430 (79)	889 (60)	0	116 (43)
2nd Line Pharmacologic	0	1,470 (100)	206 (39)	154 (57)
Specialty	39 (2)	0	14 (3)	268 (100)
Imaging	264 (15)	255 (17)	525 (100)	88 (33)

Notes. All values are n (%) where n is the number of patients within the cluster who received that order.

The training cluster data set (n = 4073) yielded 4 different models ranging from 2 to 5 clusters. The 4-cluster model was selected based on distinctiveness of physician orders (Table 2). This model was used in the validation data set and compared against the training data set to assess and confirm similarity (Appendix B). The proportion of order frequency as well as patient demographic and clinical characteristics were evaluated to determine consistency between the 2 data sets. The 4 clusters were: 1) Non-Pharm and first-Line Pharm (44%); 2) second-Line Pharm (36%); 3) Imaging (13%); and 4) Specialty (7%).

The Non-Pharm and first-Line Pharm cluster (n = 1810) was the youngest (mean age = 48) and had the largest proportion of Black patients (22%) of the clusters. They mostly had axial back pain (81%) and less disability (mean ODI = 31). In this cluster, 39% and 20% of patients received solely first-line pharmacologic or nonpharmacologic orders, respectively (Table 3). The most common combination was a nonpharmacologic order with a first-line pharmacologic order (25%). Frequent orders in this cluster were PT (n = 934; 52%), muscle relaxants (n = 940; 52%), and NSAIDs (n = 933; 52%) (Table 4).

The second-Line Pharm cluster (n = 1470) had the highest proportion of white (88%), privately insured (53%) patients, and the highest disability (mean ODI = 40) (Table 5). In this cluster, 71% of

Table 3. Common Combinations of Primary Care Physician Orders Within the First 21 Days from Initial Visit in 4073 Patients with Acute Low Back Pain

Order Combinations	Non Pharm & 1st Line Pharm	2nd Line Pharm	Imaging	Specialty
1st Line Pharm Only	697 (39)			
1st Line Pharm with Non-Pharm	453 (25)			
Non-Pharm Only	361 (20)			
2nd Line Pharm with 1st Line Pharm		419 (29)		
2nd Line Pharm Only		401 (27)		
2nd Line Pharm with 1st Line Pharm and Non-Pharm		215 (15)		
2nd Line Pharm with Non-Pharm		180 (12)		
2nd Line Pharm with 1st Line Pharm and Imaging		156 (11)		
Imaging Only			198 (38)	
Imaging with 2nd Line Pharm			118 (22)	
Imaging with Non-Pharm			107 (20)	
Imaging with 2nd Line Pharm and Non-Pharm			88 (17)	
Specialty Only				55 (21)
Specialty with 1st Line Pharm and 2nd Line Pharm				40 (15)
Specialty with 2nd Line Pharm				35 (13)
Specialty with 1st Line Pharm				28 (10)

Notes. All values are n (%) where n is the number of patients within the cluster who received that type of order or order combination. Orders or combinations of orders less frequent than 10% are excluded.

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Table 4. Specific Primary Care Physician Orders Within the First 21 Days from Initial Visit in 4073 Patients with Acute Low Back Pain

	Clusters			
Orders	Non-Pharm & 1st Line Pharm	2nd Line Pharm	Imaging	Specialty
Non-Pharmacologic				
Physical Therapy	934 (52)	464 (32)	200 (38)	42 (16)
Other*	24 (1)	16 (1)	5 (1)	1 (0)
1st Line Pharmacologic				
Acetaminophen	55 (3)	11 (1)	0	4 (1)
Muscle relaxant	940 (52)	747 (51)	0	75 (28)
NSAID	933 (52)	360 (24)	0	69 (26)
2nd Line Pharmacologic				
Benzodiazepine	0	96 (7)	17 (3)	11 (4)
Opioid	0	655 (45)	93 (18)	94 (35)
Steroid	0	913 (62)	12 (2)	91 (34)
Antidepressant	0	144 (10)	11 (2)	15 (6)
Imaging				
MRI or CT Scan	22 (1)	55 (4)	98 (19)	43 (16)
Radiography	248 (14)	210 (14)	434 (83)	51 (19)
Specialty				
Neurology or PM&R	14 (1)	0	3 (1)	118 (44)
Spine surgery	25 (1)	0	12 (2)	161 (60)

Notes. All values are n (%) where n is the number of patients who received the order within that cluster.
*Includes chiropractic, behavioral health, coaching, mind-body therapies, pain management, social work.
Abbreviations: NSAID, non-steroidal anti-inflammatory drugs; MRI, magnetic resonance imaging; CT, computed tomography; PM&R, physical medicine and rehabilitation.

patients received 1 (27%) or more than 1 (44%) second- and first-line pharmacologic orders. The most frequent orders in this cluster were steroids (n = 913; 62%), muscle relaxants (n = 747; 51%), and opioids (n = 655; 45%).

The Imaging cluster (n = 525) was the oldest (mean age = 56) and had the highest proportion of females (62%). Imaging orders were predominantly for plain radiographs (n = 434; 83%) and were combined with second-line pharm (n = 118; 22%) or nonpharm (n = 107; 20%) orders. The Specialty cluster was comparatively small (n = 268) but contained the largest proportion of patients who were stratified as high risk (38%), had back and leg pain (41%) and had pain greater than 3 months (23%).

Discussion

We determined PCP patterns of care for 9574 adults with aLBP presenting to 77 primary care clinics in 4 geographic regions. We found that PCPs often combined multiple orders rather than a single order, but that there was wide variation in the order type and combination. This frequently resulted in PCP orders being partially concordant with current guidelines (ie, referring to a recommended treatment) while also prescribing a second-line or nonrecommended medication or imaging for initial care of aLBP.

Our findings have implications for trials that have "usual care" comparators.[26] Without fully understanding what is included in usual care, estimates for comparative treatment effects may be confounded. This is, nonetheless, the reality of low back primary pain care where patient complexity is common and there are multiple choices for evidence-based treatments. And, while the recommendations from the guidelines are "strong," the quality of the evidence for the different treatments varies (eg, low quality evidence for massage, spinal manipulation and acupuncture). Various factors may influence PCP orders such as patient comorbidities, patient preferences, availability of resources, long wait-lists for nonpharmacologic clinicians, payer types, and clinician beliefs about the evidence base for the guidelines.[27] We identified some distinguishing patient-characteristics that may explain some of the variation in PCP orders.

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Table 5. Characteristics of 1401 Patients with Acute Low Back Pain Who Did Not Receive a Physician Order and 4073 Patients Clustered by Predominant Physician Orders Within 21 Days of Initial Visit

	No Order N = 1401	Non-Pharm & 1st-Line Pharm N = 1810	2nd-Line Pharm N = 1470	Imaging N = 525	Specialty N = 268	Total N = 4073
Age, mean (SD)	52 (18)	48 (17)	50 (16)	56 (18)	53 (16)	50 (17)
Women	826 (59)	1063 (59)	818 (56)	323 (62)	137 (51)	2341 (57)
Race						
White	1113 (80)	1250 (69)	1289 (88)	454 (86)	210 (79)	3203 (79)
Black	190 (14)	389 (22)	113 (8)	45 (9)	37 (14)	584 (14)
Missing/Other	96 (6)	171 (9)	68 (4)	26 (5)	19 (7)	284 (7)
Ethnicity						
Hispanic	64 (5)	102 (6)	43 (3)	15 (3)	15 (6)	175 (4)
Non-Hispanic	1291 (92)	1658 (92)	1397 (95)	499 (95)	242 (91)	3796 (93)
Missing	44 (3)	50 (2)	30 (2)	11 (2)	9 (3)	157 (4)
Location						
Baltimore, MD	243 (17)	395 (22)	161 (11)	62 (12)	56 (21)	675 (17)
Boston, MA	165 (12)	332 (18)	50 (3)	12 (2)	35 (13)	429 (11)
Pittsburgh, PA	713 (51)	736 (41)	852 (58)	370 (70)	124 (47)	2082 (51)
Salt Lake City, UT	278 (20)	347 (19)	406 (28)	81 (15)	53 (20)	887 (22)
Insurance						
Medicare	355 (25)	295 (16)	291 (20)	170 (32)	58 (22)	814 (20)
Medicaid	122 (9)	188 (10)	132 (9)	37 (7)	24 (9)	381 (9)
Private	698 (50)	885 (49)	784 (53)	228 (43)	123 (46)	2020 (50)
Missing/Other	224 (16)	442 (25)	263 (18)	90 (18)	61 (23)	856 (21)
Current Smoker						
No	915 (68)	1140 (63)	956 (65)	391 (74)	156 (59)	2643 (65)
Yes	115 (8)	179 (10)	227 (15)	51 (10)	45 (17)	502 (12)
Missing	333 (24)	491 (27)	287 (20)	83 (16)	65 (24)	926 (23)
Body Mass Index mean (SD)	29 (6)	32 (9)	32 (8)	30 (8)	32 (8)	32 (8)
STarT Back						
Low	834 (60)	686 (38)	359 (24)	188 (36)	59 (22)	1292 (32)
Medium	382 (27)	683 (38)	687 (47)	196 (37)	105 (39)	1671 (41)
High	183 (13)	441 (24)	424 (29)	141 (27)	102 (39)	1108 (27)
Baseline ODI, mean (SD)[±]	23 (17)	31 (18)	40 (19)	31 (20)	40 (21)	35 (19)
Axial back pain	1210 (86)	1472 (81)	999 (68)	356 (68)	156 (59)	2983 (73)
Back and leg pain	189 (14)	338 (19)	471 (32)	169 (32)	110 (41)	1088 (27)
Back pain >3 months	219 (16)	239 (13)	192 (13)	88 (17)	60 (23)	579 (14)

Notes. *All values are n (%) of patients within that cluster unless otherwise noted.
[±]ODI: Oswestry Disability Index; 0–100 with lower scores indicating less disability.
Abbreviations: SD, standard deviation.

Low-Moderate Risk Patterns

PCPs appeared to recognize and provide guideline concordant care to patients who had low disability and were stratified by the STarT Back score as low-risk. A common combination for patients with low to moderate risk of developing cLBP was a non-pharmacologic order with a first-line medication. This practice is congruent with guidance that recommends nonpharmacologic treatments first and, if requested by the patient, in combination with an NSAID or muscle relaxant.

High-Risk Patterns

Patients who were stratified as high risk of developing disability and had longer duration of symptoms tended to be in the clusters that received orders associated with greater risk or cost such as opioids, steroids, imaging orders, and to a lesser extent, specialty referral. It is conceivable that PCPs seeing patients with more severe presentation recommended invasive or aggressive treatments that were not guideline concordant. Thus, guideline implementation or deimplementation interventions targeting clinicians

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may need to focus on this patient subgroup. However, it is also conceivable that patients who self-report higher disability and psychological distress perceive a stronger need for advanced care and place pressure on clinicians to receive it.[28–31] This pattern of patient presentation has been described in the emergency medicine department where patients with nonspecific low back pain receive high-rates of imaging and opioid medications.[32–34] However, clinical trials do not support the premise that pain medications are more effective among patients with severely intense or disabling aLBP compared with nonpharmacologic approaches.[35,36] Our previous study suggests that opioids and nonopioid medications are associated with a higher transition to cLBP.[19]

The STarT Back tool stratifies patients into high-risk if they respond positively to statements about pain related psychological distress as these patients have been shown to have worse outcomes.[22] With this in mind, using integrated behavioral health or referring to other clinician (eg, rehabilitation) who can help patients process and cope with their pain may be more useful than medications and referrals. We say this while acknowledging that in the embedded trial (the TARGET trial) psychologically informed physical therapy did not improve outcomes among high-risk patients.[20] Yet, a program evaluation looking at implementation at 1 of the sites found implementation was challenging at multiple levels – screening in primary care, PCP referrals, scheduling visits, and attendance for psychologically informed physical therapy.[37] It may be that pain medication prescribing is common because it is convenient, routine, and has established systems for payment or coverage.[38] Previous work suggests that PCPs may select more aggressive care such as pain medication due to pressure from patients to receive immediate pain relief, concerns of patient dissatisfaction, and fear of litigation from patients.[39] Indeed, public health campaigns lead by clinicians to educate patients about the risks of overdiagnosing and overtreating LBP have been initiated in primary care and, while still in infancy, have faced resistance from patients.[40] The continued variability in practice and the persistence of guideline discordant care warrants research into implementation at multiple levels.

Our study has several limitations. Embedded within this observational cohort was a randomized trial on a PT intervention. Thus, nonpharmacologic orders, particularly PT, may have been inflated and our findings may not be generalizable to other systems that do not have strongly integrated PT care options. Low order rates of non-PT nonpharmacologic approaches may not be captured in orders (eg, clinician recommendations for yoga, mindfulness based stress reduction occurring outside the medical system). Second, our medication orders were not linked to ICD-9 or ICD-10 in the electronic health record systems. Therefore, it is possible that certain orders such as antidepressant medications were related to other patient conditions. Our data cannot provide an explanatory model for why certain guideline discordant orders may have been chosen based on patient comorbidities (eg, imaging in patients with osteoporosis or history of malignancy). Last, a cluster analysis is helpful for identifying homogeneous groups of people based on a variable or variables of interest (in our case PCP orders). Similarities between generated clusters across other patient level variables suggests that there is not absolute distinction between who receives which PCP orders.

Conclusion

Primary care physicians navigate a complex interaction between policy guidelines, patient preference, and resource availability when treating aLBP. Future research that measures clinical effectiveness and downstream utilization of guideline based combinations of treatments may be more pragmatic. In addition, implementation efforts targeted at patients and clinicians to increase use of nonpharmacologic treatment and prevent discordant care remains warranted.

The authors acknowledge the TARGET trial team.

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Appendices.

Appendix A

Appendix Table A. Breakdown of Specific Medications Within Each Category

Category	Data for Each Category
Acetaminophen	Acetaminophen
Acetaminophen	Tylenol
Antidepressants	Amitriptyline
Antidepressants	Buproprion HCL
Antidepressants	Celexa
Antidepressants	Citalopram
Antidepressants	Clomipramine
Antidepressants	Doxepin
Antidepressants	Duloxetine
Antidepressants	Escitalopram
Antidepressants	Fluoxetin
Antidepressants	Fluvoxamine
Antidepressants	Mirtazapine
Antidepressants	Nortriptyline
Antidepressants	Olanzapine
Antidepressants	Paroxetine
Antidepressants	Perphenazine-amitriptyline
Antidepressants	Prozac
Antidepressants	Quetiapine
Antidepressants	Remeron
Antidepressants	Trazodone
Antidepressants	Venlafaxine
Antidepressants	Zoloft
Behavioral Health	Consult/Referral to Behavioral Health Program
Behavioral Health	Consult/Referral to Neuropsychology
Behavioral Health	Consult/Referral to Psychiatry
Behavioral Health	Consult/Referral to Psychology
Behavioral Health	Consult/Referral to Psychology Evaluation
BENZOS	Alprazolam
BENZOS	Clonazepam
BENZOS	Diazepam
BENZOS	Klonopin
BENZOS	lorazepam
BENZOS	Oxazepam
BENZOS	Temazepam
BENZOS	Triazolam
BENZOS	Valium
Chiropractic/Osteopathic Manipulation	Consult/Referral to Chiropractic Therapy
Chiropractic/Osteopathic Manipulation	Consult/Referral to Osteopathic Manipulative Therapy
Chiropractic/Osteopathic Manipulation	Osteopathic Manipulative Tx 1 to 2 Body Regions
Chiropractic/Osteopathic Manipulation	Osteopathic Manipulative Tx 3 to 4 Body Regions
Chiropractic/Osteopathic Manipulation	Osteopathic Manipulative Tx 5 to 6 Body Regions
Chiropractic/Osteopathic Manipulation	Osteopathic Manipulative Tx 7 to 8 Body Regions
Coaching/Wellness/Lifestyle	Consult/Referral for Wellness Education

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Appendix Table A. Continued

Category	Data for Each Category
Coaching/Wellness/Lifestyle	Consult/Referral to Prescription for Wellness Health Coach
Diagnostic Imaging - MR/CT	CT Lumbar spine
Diagnostic Imaging - MR/CT	CT Lumbar spine
Diagnostic Imaging - MR/CT	MR Lumbar and Thoracic spine
Diagnostic Imaging - MR/CT	MR Lumbar spine
Diagnostic Imaging - MR/CT	MR Lumbo-sacral spine
Diagnostic Imaging - XRAY	Xray Lumbar Spine 2 or 3 views
Diagnostic Imaging - XRAY	Xray Lumbar Spine Minimum 4 views
Diagnostic Imaging - XRAY	XRay Lumbar Spine Minimum 4 views with Oblique
Diagnostic Imaging - XRAY	Xray Lumbar Spine with Flex and Ext.
Diagnostic Imaging - XRAY	XRay pelvic complete minimum 3 views
Diagnostic Imaging - XRAY	XRay Sacroiliac Joints (G)
Diagnostic Imaging - XRAY	XRay Sacroiliac Joints 1 or 2 Views
Diagnostic Imaging - XRAY	XRay Sacroiliac Joints 3+ Views
Diagnostic Imaging - XRAY	XRay Sacroiliac Joints less than 3 Views
Diagnostic Imaging - XRAY	XRay Sacroiliac Joints Minimum 3 Views
Diagnostic Imaging - XRAY	XRay Sacrum/Coccyx 2 Views
Diagnostic Imaging - XRAY	XRay Sacrum/Coccyx 2+ Views
Diagnostic Imaging - XRAY	XRay Sacrum/Coccyx Minimum 2 Views
Diagnostic Imaging - XRAY	XRay Spine Lumbar (G)
Diagnostic Imaging - XRAY	XRay Spine Lumbar 1 View
Diagnostic Imaging - XRAY	XRay Spine Lumbosacral 2 or 3 Views
Diagnostic Imaging - XRAY	XRay Spine Lumbosacral 4+ Views
Diagnostic Imaging - XRAY	XRay Spine Lumbosacral w/ Bending 6+ Views
Diagnostic Imaging - XRAY	XRay Spine Scoliosis Study (G)
Diagnostic Imaging - XRAY	XRay Spine Thoracolumbar 2 Views
Diagnostic Imaging - XRAY	XRay Spine Thoracolumbar 2+ Views
Mind and Body Therapies	Consult/Referral for Acupuncture
Mind and Body Therapies	Consult/Referral for Musculoskeletal Health
Mind and Body Therapies	Consult/Referral Massage Therapy
Mind and Body Therapies	Massage Therapy
MUSCLE RELAXANT	Baclofen
MUSCLE RELAXANT	Carisoprodol
MUSCLE RELAXANT	Chlorzoxazone
MUSCLE RELAXANT	Cyclobenzaprine
MUSCLE RELAXANT	Flexeril
MUSCLE RELAXANT	Metaxalone
MUSCLE RELAXANT	Methocarbamol
MUSCLE RELAXANT	Orphenadrine
MUSCLE RELAXANT	Tizanidine
Neurology	Consult/Referral to Neurology
NSAIDS	Celecoxib
NSAIDS	Diclofenac
NSAIDS	Diclofenac-epolamine
NSAIDS	Diflunisal
NSAIDS	Etodolac
NSAIDS	Flurbiprofen
NSAIDS	Ibuprofen
NSAIDS	Ibuprofen-famotidine

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Appendix Table A. Continued

Category	Data for Each Category
NSAIDS	Indomethacin
NSAIDS	Ketorolac
NSAIDS	Meloxicam
NSAIDS	Motrin
NSAIDS	Nabumetone
NSAIDS	Naprosyn
NSAIDS	Naproxen
NSAIDS	Oxaprozin
NSAIDS	Piroxicam
NSAIDS	Sulindac
NSAIDS	Toradol
NSAIDS-topical	Diclofenac cream
NSAIDS-topical	Voltaren cream
Opioids	Acetaminophen-codeine
Opioids	Butabital-acetaminophen-caffeine-codeine
Opioids	Fentanyl
Opioids	Hydrocodone
Opioids	Hydrocodone-acetaminophen
Opioids	Hydromorphone
Opioids	Methadone
Opioids	Morphine
Opioids	Morphone
Opioids	Oxycodone
Opioids	Oxycodone-acetaminophen
Opioids	Oxymorphone
Opioids	Tramadol
Opioids	Tramadol HCL
Opioids	Tramadol-acetaminophen
Opioids	Vicodine
Pain Management	Consult/Referral for Peti-Chronic Pain Treatment
Pain Management	Consult/Referral to Pain Clinic
Pain Management	Consult/Referral to Pain Management
Pain Management	Consult/Referral to Physical Medicine and Rehabilitation
Pain Management	Consult/Referral to Sports Medicine
Physical Therapy/Rehabilitation	Consult/Referral to Aqua Therapy
Physical Therapy/Rehabilitation	Consult/Referral to Flexibility Exercise
Physical Therapy/Rehabilitation	Consult/Referral to Physical Therapy
Physical Therapy/Rehabilitation	Physical Therapy (PT) Evaluation and Treatment
Physical Therapy/Rehabilitation	Physical Therapy (PT) Outpatient Evaluation and Treatment
Psychologically Informed Physical Therapy	Consult/Referral to Psychologically Informed Physical Therapy (Stratified approach for LBP)
Social Work	Consult/Referral to Social Work
Social Work	Consult/Referral to Social Work/Case Management
Spine Surgery	Consult/Referral to Neurosurgery
Spine Surgery	Consult/Referral to Neurosurgery spine
Spine Surgery	Consult/Referral to Orthopedics
Spine Surgery	Consult/Referral to Orthopedics-spine
Steroids	Dexamethasone
Steroids	Dexamethasone - injection
Steroids	Hydrocortisone

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Appendix Table A. Continued

Category	Data for Each Category
Steroids	Medrol
Steroids	Methylprednisolone
Steroids	Methylprednisolone acetate - injection
Steroids	Methylprednisolone sodium succinate - injection
Steroids	Prednisone

Abbreviations: NSAID, non-steroidal anti-inflammatory drugs; MRI, magnetic resonance imaging; CT, computed tomography.

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Appendix Table B. Comparison of Training Data and Validation Data Clusters in the 4-Cluster Model

	Validation		Training		Validation		Training		Validation		Training		Validation		Training	
	2nd Line Pharm		2nd Line Pharm		Non-Pharm and 1st Line Pharm		Non-Pharm and 1st Line Pharm		Imaging		Imaging		Specialty		Specialty	
	n = 1470		n = 1747		n = 1810		n = 1789		n = 525		n = 305		n = 268		n = 232	
Female n, %	818	56%	985	56%	1063	59%	1032	58%	323	62%	196	64%	137	51%	125	54%
Age mean, std	50	16	51	16	48	17	49	17	56	18	55	20	53	16	54	16
Body Mass Index, mean		32		32		32		32		30		30		32		32
Site																
BMC	50	3%	56	3%	332	18%	293	16%	12	2%	15	5%	36	113%	23	109%
IMH	406	28%	472	27%	347	19%	335	19%	81	15%	50	16%	53	20%	46	20%
JHU	162	11%	171	10%	395	22%	411	23%	62	12%	38	12%	56	21%	52	22%
UPMC	852	58%	1048	60%	736	41%	750	42%	370	70%	202	66%	124	47%	112	48%
Anxiety or depression n, %	141	10%	143	8%	72	4%	67	4%	30	6%	12	4%	19	7%	20	9%
Obese n, %	775	53%	908	52%	948	52%	967	54%	222	42%	118	39%	139	52%	133	57%
Insurance																
SelfPay/Other/Missing	263	18%	289	17%	442	24%	408	23%	90	17%	37	12%	61	23%	48	21%
Medicaid	132	9%	141	8%	188	10%	186	10%	37	7%	21	7%	24	9%	18	8%
Medicare	291	20%	326	19%	295	16%	274	15%	170	32%	93	31%	58	22%	61	26%
private	784	53%	991	57%	885	49%	921	51%	228	43%	153	50%	123	46%	105	45%
Smoking status n,%																
Not current smoker	956	65%	1122	64%	1140	63%	1098	61%	391	74%	234	77%	156	59%	140	60%
Current smoker	227	15%	275	16%	179	10%	184	10%	51	10%	22	7%	45	17%	27	12%
Missing/unknown	287	20%	350	20%	491	27%	507	28%	83	16%	48	16%	65	24%	65	28%
Race n,%																
White	1289	88%	1556	89%	1250	69%	1264	71%	454	86%	257	85%	210	79%	194	84%
Black	113	8%	116	7%	389	21%	374	21%	45	9%	32	11%	37	14%	25	11%
Missing	32	2%	37	2%	75	4%	81	5%	12	2%	6	2%	8	3%	4	2%
Other	36	2%	38	2%	96	5%	70	4%	14	3%	9	3%	11	4%	9	4%
Hispanic n,%																
Non-Hispanic	1397	95%	1652	95%	1658	92%	1612	90%	499	95%	284	93%	242	91%	214	92%
Hispanic	43	3%	44	3%	102	6%	102	6%	15	3%	9	3%	15	6%	10	4%
Missing	30	2%	51	3%	50	3%	75	4%	11	2%	11	4%	9	3%	8	3%

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Appendix Table B. Continued

	Validation		Training		Validation		Training		Validation		Training		Validation		Training	
	2nd Line Pharm		2nd Line Pharm		Non-Pharm and 1st Line Pharm		Non-Pharm and 1st Line Pharm		Imaging		Imaging		Specialty		Specialty	
	n = 1470		n = 1747		n = 1810		n = 1789		n = 525		n = 305		n = 268		n = 232	
Back pain diagnosis n,%																
Axial back pain	999	68%	1118	64%	1472	81%	1452	81%	356	68%	225	74%	156	59%	123	53%
Back and leg	471	32%	629	36%	338	19%	337	19%	169	32%	79	26%	110	41%	109	47%
Duration of LBP n,%																
Less than 1 month	996	68%	1188	68%	1147	63%	1115	62%	280	53%	143	47%	117	44%	113	49%
1 to 3 months	282	19%	365	21%	424	23%	441	25%	157	30%	101	33%	89	33%	77	33%
More than 3 months	192	13%	194	11%	239	13%	233	13%	88	17%	60	20%	60	23%	42	18%
STarT Back Category																
High	424	29%	482	28%	441	24%	388	22%	141	27%	44	14%	102	38%	94	41%
Low	359	24%	441	25%	686	38%	702	39%	188	36%	141	46%	59	22%	50	22%
Medium	687	47%	824	47%	683	38%	699	39%	196	37%	119	39%	105	39%	88	38%
Chronic at 6 months n,%	328/888	37%	343/1034	33%	267/966	28%	240/893	27%	110/295	37%	42/170	25%	87/151	58%	53/120	44%
ODI Baseline n, mean	1426	40	1698	38	1749	31	1737	31	515	31	298	25	260	40	229	39
ODI 6 Months n, mean	891	22	1034	22	973	19	899	18	298	22	172	17	151	29	121	25

	CLUSTER															
	Validation		Training		Validation		Training		Validation		Training		Validation		Training	
	2nd Line Pharm		2nd Line Pharm		Non-Pharm and 1st Line Pharm		Non-Pharm and 1st Line Pharm		Imaging		Imaging		Specialty		Specialty	
	n = 1470		n = 1747		n = 1810		n = 1789		n = 525		n = 305		n = 268		n = 232	
Non-Pharm	494	34%	591	34%	962	53%	901	50%	209	40%	117	38%	42	16%	40	17%
Pharm1	889	60%	948	54%	1430	79%	1438	80%	0	0%	0	0%	116	43%	85	37%
Pharm2	1470	100%	1747	100%	0	0%	12	1%	206	39%	0	0%	154	57%	141	61%
Specialty	0	0%	0	0%	39	2%	69	4%	14	3%	7	2%	268	100%	232	100%
Imaging	255	17%	460	26%	264	15%	266	15%	525	100%	305	100%	88	33%	75	32%

Abbreviations: BMC, Boston medical center; IMH, Institute of mental health; UPMC, University of Pittsburgh medical center; JHU, Johns Hopkins university.

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