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Predictors of daily pain medication use in individuals with recurrent back pain

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Abstract

Purpose—A key component to chronic pain management regimens is the use of analgesic medications. Psychological factors, such as mood states, may also affect the use of pain medications for individuals with chronic pain, but few observational studies have examined how these factors may predict pain medication use at the daily level.

Methods—Daily assessments from 104 individuals with back pain were used to examine fluctuations in daily pain intensity, mood, sleep quality, and physical activity as predictors of the likelihood of pain medication (opioid and non-opioid) use and levels of medication use on the same day.

Results—Pain intensity and mood ratings significantly predicted whether participants used pain medication on the same day, while only pain intensity predicted whether participants used more medication than usual. Further, current opioid users were more likely to increase the amount of their medication use on days of higher pain.

Discussion—This article identifies fluctuations in daily pain intensity and mood as salient predictors of daily pain medication use in individuals with recurrent back pain. The current study is among the first to highlight both pain and mood states as predictors of daily pain medication use in individuals with back pain, though future studies may expand on these findings through use of higher-resolution daily medication use variables.

Keywords

Daily diaries; pain intensity; mood; opioid medications; medication use

Medications are a common component of chronic pain management regimens and, optimally, reduce pain to allow patients maintain better function and quality of life. However, there may be substantial variability in how pain medications are used. In the most severe of cases, individuals with chronic pain are susceptible to the development of aberrant

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use of these medications across time [1], with the most common behavior being medication overuse [1]. However, even in cases where frank substance abuse is not evident, there may nevertheless be variability in the degree to which individuals rely on their pain medications, which may be due to both physical and psychological factors. Although the majority of prior studies have explored this question in the context of misuse of pain medications (particularly regarding abuse of opioid medications), modeling more normative patterns of pain medication use in individuals with chronic pain may be useful for a few reasons. First, given the presumption that most individuals with chronic pain do not misuse their medications, there is value in establishing normative models of pain medication use in chronic pain populations. Second, establishing predictors of normative medication use in non-substance abuse samples provides a baseline model against which predictors of future addiction and medication abuse may be compared.

Several factors have been associated with differential patterns of pain medication use in chronic pain. However, as most prior studies in this area focus on aberrant pain medication use, we draw from this literature as a means of establishing a set of potential predictors of pain medication use. Pain medication use may be more problematic in individuals with a history of dependence or abuse of pain medications or other substances [2, 3], worse concurrent levels of pain and pain-related physical dysfunction [4], lower levels of physical activity and occupational function [5], greater levels of maladaptive beliefs about pain, such as pain catastrophizing [6], and a tendency to use analgesic medications for other symptoms, such as stress or poor sleep [7]. However, despite evidence that disrupted sleep is related to use of some analgesic medications [8], few studies have examined sleep disturbance as a predictive factor in models of pain medication use. Further, a key predictive factor in extant predictive models of pain medication use is emotional distress [9, 10]. Similarly, individuals with chronic pain and significant psychological distress are more likely to misuse pain medications [2, 9, 11, 12] and to be diagnosed with an opioid use disorder [13].

To date, many studies in this area have used retrospective self-report measures across weeks, months, or indefinite periods of time in measuring medication use. Self-report measures utilizing broad windows of time may be less reliable in their representation of pain-relevant symptoms such as pain intensity and fatigue [14, 15], and recall periods of approximately 1 day may be preferable for this type of assessment [14, 15]. Daily approaches often show superiority over single-time point designs due to their greater reliability, but also because they allow for modeling of dynamics of pain, mood, and behavior. Despite these advantages, there is a relative dearth of studies examining pain medication use on a daily level. Of note, a recent publication by Martel and colleagues [16] is among the first in this area, and their results suggest that daily variations in pain intensity were only weakly related to increased opioid medication craving in individuals with chronic pain. Notably, these researchers also noted that baseline levels of affective distress predicted opioid cravings, but did not measure these relationships at the daily level, highlighting a need to answer this question in future studies.

Consequently, there is a need to further develop research in the area of daily pain medication use, particularly given the multifactorial nature of potential medication misuse. The current study sought to extend this literature by examining 4 potential predictors of daily medication

use in a sample of 104 individuals with recurrent back pain. We sought to characterize any relationships between daily ratings of pain, sleep, physical activity, and mood to both the likelihood of using pain medications on a given day and the likelihood of using a greater amount of pain medication on the same day. Given the broad public health implications of opioid medication use in chronic pain, we opted to conduct an exploratory analysis using a binary opioid use variable, measured at baseline, as both a predictor of daily pain medication use and as a moderator of other effects in the final model.

Methods

All study procedures were approved by the Stanford University School of Medicine Institutional Review Board. All participants provided their consent before participating in the study.

Procedures

The current study was an observational daily diary study that recruited participants from a pool of interested individuals contacting the research laboratory regarding studies of substance use, chronic back pain, and alternative and complementary treatments for chronic back pain. If participants agreed to participate, they were provided an online consent and enrolled in the online study through the REDCap data collection system [17]. Participation in the current study involved completion of baseline questionnaires, daily assessments across 28 days, and an additional set of follow-up questionnaires 3 months after completion of the study. Each daily assessment was sent at 8am, Pacific Standard Time. Participants were invited to participate if they had any form of recurrent back pain, were over the age of 18, and were willing and able to complete daily assessments. No compensation was provided for study participation, and contact with study staff was minimal beyond initial enrollment. Daily assessments were designed to be brief (9 items) to minimize participant burden.

Participants

153 participants who self-identified as having recurrent back pain were initially enrolled in the study and completed at least 1 daily measure. However, as participants showed a significant degree of variability in their adherence to daily assessments, we opted to include for analysis only participants who completed at least 14 out of 28 diaries (50% compliance), leaving a final sample of 104 participants. The large degree of attrition in terms of participant responses was somewhat unsurprising, as participants received minimal contact from study staff after their initial enrollment and did not receive regular follow-up or compensation for a higher number of completed diaries. Using this reduced sample, participants completed an average of 24.40 out of 28 diaries (87.1% completion rate). Of note, there were no significant differences in average levels of pain, sleep, mood, or physical activity between participants completing more than 50% of diaries and those completing less than 50% of diaries ($p > .26$ in all cases). The sample was 61.5% female (N = 64). Patient age in the current sample ranged from 20 to 77 years (M = 53.1, SD = 13.2). Most of the sample identified as Caucasian (N = 87; 83.7%), with smaller numbers of participants who identified as Asian or Asian-American (N = 9; 8.7%), American Indian or Alaska Native (N = 3, 2.9%), Pacific Islander or Native Hawaiian (N = 3, 2.9%), and Black or African

American (N = 1, 1.0%). 2 participants reported their ethnicity as “unknown,” and 4 did not report their ethnicity. 11 participants (10.6%) reported being of Latino heritage. In the current sample, the median education level was a completed Bachelor’s Degree. Regarding work status, 45.2% of the sample (N = 47) reported being currently employed at the time of data collection, and 22.1% (N = 23) of the sample reported their status as “disabled.”

Regarding pain characteristics of the sample, the median duration of pain in the current sample was in a range of 1-5 years. 65 participants (62.5% of the sample) reported radicular symptoms into their limbs over the prior 2 weeks. 20 participants reported a history of at least one back surgery; of these participants, 9 participants reported a prior spinal fusion. The majority of the sample reported some type of concurrent non-back pain complaint over the 4-week period prior to data collection: 94 participants (90.4% of the sample) reported pain in their arms, legs, or other joints, 66 participants (66.3% of the sample) reported widespread bodily pain, 65 participants (64.4% of the sample) reported ongoing headaches, and 52 participants (50% of the sample) reported stomach pain. 27 participants reported using opioids currently at the time of data collection (26%), 33 participants were not taking opioids at the time of data collection, and 41 respondents did not answer this question.

Measures

Pain medication use—Daily pain medication use was assessed via 2 questions: a binary “yes/no” question (“Did you take any pain medication over the past 24 hours?”), and a question assessing general use patterns (“How much pain medication did you use over the past 24 hours?”). For the second question, participants could indicate that they took 1) less medication than usual; 2) their standard amount of medication; or 3) more medication than usual. Frequencies of the pain medication use variables can be found in Table 1. Daily pain medication use questions did not distinguish between different classes of pain medication.

Pain intensity—Participants were asked to rate their average level of average back pain over the previous 24 hours using a 0-100 visual analog scale (VAS), where 0 referred to “no pain at all” and 100 referred to “worst pain imaginable.” VAS scales have been validated for use in chronic pain populations.[18]

Mood—As with pain intensity, mood was assessed via a 0-100 visual analog scale. Participants were asked their overall mood from 0 (“Very negative”) to 100 (“Very positive”) over the previous 24 hours. The reliability and validity of using VAS scales for mood assessment have been previously demonstrated.[19]

Activity—Participants were asked to rate their level of physical activity over the previous 24 hours using a 0-100 VAS scale, where 0 referred to “Inactive” and 100 referred to “Extremely active.”

Sleep quality—Participants were asked to rate the quality of their sleep using a single-item measure: “How would you rate the quality of your sleep over the past 24 hours?” using a 5-choice Likert scale, coded from 1 (“Very poor”) to 5 (“Very good”).

Current opioid use—Participants were asked if they were currently taking any opioid medication at their baseline assessment. Current opioid status was quantified as a binary variable ("yes/no").

Analytic Plan

Separate multilevel logit models were estimated in predicting the likelihood of using pain medication on a given day, as well as predicting the likelihood of different levels of pain medication use (i.e., using less medication than usual, using a typical amount of medication, or using more medication than usual). All analyses were conducted using Mplus version 6.12 [20]. All daily predictors were centered on cluster means (i.e., average scores for each participant across the 28-day span). First, single-predictor models were estimated in which each daily predictor (pain intensity, mood, sleep quality, and physical activity) was modeled as a predictor of each pain medication use variable. Second, a fully-estimated path model was constructed for each pain medication use variable in which the effects of all predictors were modeled simultaneously. All models were estimated as multilevel structural equation models using Full Information Maximum Likelihood estimation to account for missing data and the TYPE = COMPLEX command, which estimates models using level-1 (daily) variance, while controlling for level-2 (person-level) variance. As both outcomes were categorical, models were estimated using a multilevel logit function and Monte Carlo integration with 500 integration points. Due to the use of Monte Carlo integration in estimating these models, it was not possible to compute standardized path coefficients; as a result, all path coefficients are presented in unstandardized form. As a secondary step, opioid status was included as a predictor in all fully-specified models, and was tested as a moderator of any significant predictors of pain medication use in the final estimated models. Participant data were excluded from moderation analyses if they did not complete the opioid use question. Intraclass correlations were estimated for all continuous daily variables; these scores reflect the degree of clustering (i.e., stability of scores) within each variable across the data collection period.

Results

Single-predictor models

Descriptive statistics and intraclass correlations for the daily variables can be found in Table 2. When each study predictor was modeled as a sole predictor of the binary (yes/no) pain medication variable, results indicated that participants were more likely to use pain medications on days of higher pain (B = .019, $p = .003$) and poorer mood (B = -.022, $p < .001$). The odds ratios and confidence intervals of odds ratios of each single-predictor model can be found in Table 3. The effects of physical activity (B = .010, $p = .051$) and sleep quality (B = -.216, $p = .072$) on the likelihood of using a pain medication did not reach statistical significance. Similarly, respondents were more likely to use greater amounts of pain medication than usual on days of higher pain (B = .019, $p = .001$). However, the likelihood of using more medication than usual was not significantly related to daily mood (B = -.012, $p = .056$), physical activity (B = -.002, $p = .65$), or sleep quality on the previous night (B = -.227, $p = .079$).

Fully-specified models

Odds ratios and confidence limits for the fully-estimated models can be found in Table 4. When all study variables were simultaneously modeled as predictors of the likelihood of using pain medication on a given day, results indicated that participants were more likely to use medication on days of higher pain intensity (B = .018, p = .004) and poorer mood (B = −.021, p = .002), independent of other factors in the model. Sleep quality (B = .107, p = .38) and physical activity levels (B = -.006, p = .25) did not significantly predict the likelihood of using pain medication or not on a given day. In predicting the magnitude of pain medication use, however, only higher daily levels of pain intensity (B = .020, p = .001) were found to predict a higher likelihood of using more pain medication than usual, while mood ratings (B = -.007, p = .31), sleep quality (B = -.049, p = .73), and physical activity levels (B = -.003, p = .44) did not.

Opioid status as a moderator

Opioid status was found to have a main effect on likelihood of medication use (B = .990, p = .017), above and beyond the effects of daily variables, such that participants who reported a current opioid prescription tended to take medications on more days across the study period than patients without an opioid prescription. Opioid status was only marginally related to likelihood of using more medication than usual (B = .571, p = .051). When opioid status was modeled as a moderator of significant effects in the fully-specified model in participants who completed this question (N = 52), a significant interaction was noted between opioid status and pain ratings in predicting the likelihood of using more pain medication than usual (interaction B = .026, p = .022). This interaction suggests that individuals currently using opioids were more likely to use higher amounts of their pain medication than usual on days of higher pain than non-opioid users. However, opioid status did not moderate the effects of daily pain intensity or daily mood on the likelihood of using a pain medication or not (p > .30 in both cases).

Discussion

The current study examined 4 potential predictors of daily medication use (pain intensity, mood, activity, sleep quality) in a sample of 104 individuals with recurrent back pain. Participants were more likely to use pain medication on days of higher pain intensity and poorer mood; these effects both remained significant when modeled simultaneously. However, only higher daily levels of pain intensity were predictive of taking more pain medication than usual. Further, individuals currently using opioids were more likely to use higher amounts of pain medication than usual on days of higher pain than non-opioid users. The current study is the first to examine dynamic relationships between pain intensity, mood, and daily pain medication use.

Our results suggest that, for the most part, respondents reported taking their pain medications in a way that might be considered medically indicated (i.e., primarily to treat their pain by taking medications when pain is higher). Notably, however, opioid use status appeared to modify these relationships. Participants reporting current opioid use were more likely to use more pain medication than usual on days of higher pain, though they did not

show any increased tendency to do so on days of poorer mood. It should be noted that our findings do not allow for conclusions about medication misuse in the current study; questions were not designed to assess misuse of medications, only frequency and general deviations from typical use. Nevertheless, it is possible that these patterns of increased pain medication use among opioid users and on days of higher pain may reflect an increased risk for opioid misuse if pain proves to be intractable over time.

Conversely, poorer daily mood was associated with the likelihood of using pain medication but, contrary to our hypotheses, was not significantly related to the likelihood of using more medication than usual. These results suggest that daily fluctuations in mood may be a subtler influence on pain medication use in community-based samples of individuals with chronic pain; poorer-than-usual daily mood appeared to increase the proclivity of respondents to use a medication when they might not otherwise, but did not appear to affect their choice about how much medication to use. Several explanations exist for these findings. It may be that, for individuals with co-morbid psychiatric or substance abuse disorders, the relationships between pain intensity, mood, and medication use may be stronger. When examining chronic opioid therapy, in patients with no pre-existing substance abuse history receiving chronic opioid therapy for chronic non-cancer pain, depression was associated with self-reported opioid misuse in a previous cross-sectional study [7]. As our analyses did not detect this tendency towards increased use of pain medications in our sample, it may be that the largely non-clinical nature of our sample may be the reason. Although most participants reported moderate-to-high levels of daily pain intensity, the presence of overlapping pain complaints in addition to recurrent back pain, and a prolonged duration of pain, our sample was essentially a community-based sample of individuals who self-identified as having recurrent or chronic back pain. We did not assess the presence of co-morbid psychiatric or substance use disorders, and individuals with these conditions may show a considerably stronger relationship between pain medication use and emotional distress. Alternatively, it may be that those participants in our sample who reported poorer daily mood may have been experiencing chronic and consistent symptoms of depressed mood, which may contribute to consistently elevated pain medication use but may not manifest through daily fluctuations in pain medication use.

Despite the somewhat equivocal nature of our results relating mood to pain medication use, these results nevertheless suggest fluctuations in both pain intensity and mood states may contribute to different medication use patterns at the daily level. Recognizing this susceptibility to rely on medication for pain management highlights the value of interdisciplinary pain management (including physical therapy and psychotherapeutic interventions that emphasize alternative and typically non-pharmacological pain coping strategies), as well as the need to account for psychological comorbidities when initiating analgesic prescriptions, even among individuals with chronic pain who may not meet criteria for a mood or substance use disorder.

Limitations

In our study, participants reporting baseline opioid use were more likely to use higher amounts of pain medication than usual on days of increased pain than non-opioid users.

However, one important caveat to note is that the type of pain medication taken on any given day was not recorded. Thus, we cannot draw clear conclusions as to whether participants were taking over-the-counter vs. prescribed analgesics. More importantly, our results do not distinguish between the use of opioid and non-opioid analgesics at the daily level. It is also notable that a relatively small number of our participants (26% of the sample) reported taking opioid medication, while a larger proportion (39%) did not answer this question. The relatively small number of observations in our opioid variable may have suppressed or altered some of the potential effects of this variable, and warrant replication in a larger sample. Additionally, our daily assessments did not necessarily indicate that they were taking more pain medication than prescribed, nor did they assess doses of pain medications or the magnitude of deviation from prescribed medication doses at the daily level, which may be stronger indicators of aberrant pain medication use.

Future directions

As noted previously, more detailed daily assessments of pain medication (i.e., the types and dosages of medications used each day) would expand the applicability of our findings. Additionally, understanding whether the same patterns of mood-influenced medications occur across different classes of pain medication (e.g., over-the-counter analgesics vs. prescription opioids) may also help providers risk-stratify patients prior to prescribing pain medications. Further, opioids may directly affect mood states, as patients receiving chronic methadone maintenance therapy continue to display mood stabilization at peak concentrations and increased mood disturbances at trough concentrations [21-27]. These findings suggest that the chronicity of opioid use may be a key factor in examining how mood and pain medication use interrelate. Additionally, a longer-term longitudinal assessment of mood (e.g., the incidence of clinically-significant mood changes such as major depressive episodes) may be warranted and more predictive of prolonged and excessive medication use. As our current study included a community-based sample of individuals with recurrent back pain, it is unclear how their reports of daily medication use patterns may compare to those of patients with chronic non-cancer pain receiving treatment in tertiary pain management centers, or those presenting to primary care providers for further management. Consequently, our results require validation in other chronic pain samples, particularly among those with co-morbid mood or substance use disorders.

Conclusions

Using daily assessments of medication use, pain, mood, activity, and sleep quality, our results indicated that participants were more likely to use pain medication on days of higher pain intensity and poorer mood. Higher daily levels of pain intensity were also associated with taking more pain medication than usual. In addition, individuals reporting opioid use at baseline were more likely to use higher amounts of pain medication than usual on days of higher pain intensity than non-opioid users. More detailed daily assessments of medication use, pain, and mood are warranted in future studies, which may illuminate risk factors for the development of maladaptive patterns of medication use in individuals with chronic pain.

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Table 1

Frequencies of Pain Medication Use Variables.

Study Variable	Frequency (N, %)
Pain Medication Use (Yes/No)	
Yes	1217 (48.9%)
No	1264 (50.8%)
Pain medication use quantity	
Less than usual	126 (10.4%)
Usual amount	811 (66.7%)
More than usual	279 (22.9%)

Table 2

Means, Standard Deviations, and Intraclass Correlations of Daily Study Variables.

Study Variable	Mean (SD)	Intraclass Correlation
VAS Average Pain Intensity	46.66 (24.64)	.744
VAS Physical Activity	50.44 (23.69)	.486
VAS Mood	61.52 (21.16)	.567
Sleep Quality	3.04 (1.04)	.493

Note: VAS scores were assessed on a 101-point scale from 0-100.

Note: Scores are based on data from 104 individuals with back pain

Table 3

Odds ratios for Single-Predictor Models

	Yes/No Meds	Increased Use
Average Pain	1.019 [1.006, 1.031]	1.019 [1.008, 1.031]
Sleep	0.806 [.637, 1.109]	0.797 [.619, 1.027]
Mood	0.978 [.967, .990]	0.988 [.975, 1.000]
Physical Activity	0.990 [.981, 1.000]	0.998 [.991, 1.006]

Note: Odds ratios refer to change in likelihood of medication use per one-point increase in each variable (101-point VAS scores for daily measures).

Note: 95% confidence intervals for odds ratios represented in brackets after each estimate

Table 4

Odds ratios for Fully-Specified Models

	Yes/No Meds	Increased Use
Average Pain	1.018 [1.006, 1.031]	1.020 [1.008, 1.033]
Sleep	1.112 [.879, 1.408]	0.952 [.718, 1.262]
Mood	0.980 [.966, .993]	0.993 [.981, 1.006]
Physical Activity	0.994 [.985, 1.004]	.997 [.990, 1.004]

Note: Odds ratios refer to change in likelihood of medication use per one-point increase in each variable (101-point VAS scores for daily measures).

Note: 95% confidence intervals for odds ratios represented in brackets after each estimate