Management of Obstructive Sleep Apnea and Comorbid Insomnia:

A Mixed-Methods Evaluation

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ABSTRACT

The purpose of this study was to examine the process of care in an interdisciplinary sleep clinic for patients with obstructive sleep apnea (OSA) and comorbid insomnia. A mixed-methods approach was used to examine clinical and patient-centered measures for 34 patients who received positive-airway pressure and/or cognitive-behavior therapy for insomnia. The results revealed baseline-to-follow-up improvements on several self-reported sleep parameters and measures of daytime functioning. Qualitative analyses from patient interviews revealed three themes: conceptual distinctions about each sleep disorder, importance of treating both sleep disorders, and preferences with regards to the sequence of treatment. These findings indicate that patients with OSA and comorbid insomnia encounter unique challenges and a dimensional approach to assessment and treatment is proposed for future research.

Key Words: obstructive sleep apnea, comorbid insomnia, cognitive-behavior therapy, positive airway pressure

INTRODUCTION

Insomnia and obstructive sleep apnea (OSA) are two highly prevalent sleep disorders, with the co-occurrence of both insomnia and OSA symptoms ranging from 55% to 84% of patients presenting to sleep clinics (Krakow & Ulibarri, 2013; Krell & Kapur, 2005; Lichstein, Thomas, Woosley, & Geyer, 2013; Subramanian et al., 2011) and 20 to 40% when more stringent criteria consistent with an insomnia disorder are applied (Krakow, Ulibarri, Romero, & McIver, 2013; Smith, Sullivan, Hopkins, & Douglas, 2004). While the etiological relationship between OSA and comorbid insomnia remains unclear, the presence of both OSA and insomnia presents challenges to traditional management approaches focusing on only one disorder. For example, polysomnography is not routinely used for patients who complain of chronic insomnia and occult OSA might remain undetected (Krakow et al., 2001; Lichstein, Riedel, Lester, & Aguillard, 1999). The comorbidity can also impact treatment effectiveness, as the presence of insomnia has been found to be a predictor of poor compliance with positive-airway pressure (PAP), the standard treatment for OSA (Bjornsdottir et al., 2013; Pieh et al., 2013; Wallace, Shafazand, Aloia, & Wohlgemuth, 2013; Wickwire, Smith, Birnbaum, & Collop, 2010).

Responding to these challenges, multidisciplinary teams have emerged as a recommended approach to improve patient outcomes and cost-effectiveness in sleep clinics. A multidisciplinary model that has been used for patients with comorbid OSA and insomnia is the combination of behavioral sleep medicine (BSM) with a standard sleep medicine clinic (Guilleminault, Davis, & Huynh, 2008; Krakow et al., 2004; Ong & Crisostomo, 2013). Krakow and colleagues (2004), examined outcomes from a sequential multidisciplinary treatment approach using cognitive-behavior therapy for insomnia (CBTI) first, followed by OSA treatment, using PAP, oral appliance, or turbinectomy. The findings revealed that outcomes on

insomnia severity and daytime functioning were optimized after patients received both CBTI and an OSA treatment relative to CBTI only. Using a prospective crossover design, Guilleminault and colleagues (2008) examined a combination of CBTI and a surgical intervention for those with mild OSA and insomnia, revealing that the optimal pathway for improving objective and subjective measures of sleep involved surgical intervention for OSA followed by CBTI. Although these studies provide preliminary evidence to support the use of CBTI in combination with an established OSA treatment, patient-centered issues related to education about treatment pathways and acceptability of a multidisciplinary approach have not yet been reported.

The aim of this study was to examine the process of care from the patient perspective and to identify important issues related to the assessment and delivery of treatment within an interdisciplinary sleep clinic for patients with OSA and comorbid insomnia. To carry out this aim, we used a mixed-methods approach to gather quantitative and qualitative data on both clinical and patient-centered measures. This approach is useful in generating new hypotheses about clinical care by integrating clinical data with themes that are derived directly from the patient perspective (Wittink, Barg, & Gallo, 2006). Given that the interest was focused on patient care rather than treatment outcomes, we used an observational design across a range of treatment pathways to optimize generalizability to routine practice in sleep clinics.

METHODS

Standard Clinical Procedures and Setting

The Rush Sleep Disorders Center is accredited by the American Academy of Sleep Medicine (AASM) with an interdisciplinary team consisting of a sleep medicine clinic, staffed by physicians, and a BSM clinic, staffed by psychologists (described in Ong & Crisostomo, 2013). Figure 1 provides an overview of our treatment model. Patients who presented for OSA

evaluation were seen by physicians in the sleep medicine clinic. All patients were first seen for an initial clinic evaluation, which included a review of the patient's presenting complaint, medical and psychiatric history, and a physical examination. Following this evaluation, patients with probable OSA received an in-lab overnight diagnostic polysomnography (PSG) study following established guidelines (Epstein et al., 2009). Scoring was conducted by registered polysomnography technologists following the AASM Manual for Scoring Sleep (Iber, Ancoli-Israel, Chesson, & Quan, 2007) and reviewed and interpreted by the sleep physicians. When OSA was diagnosed, patients received a PAP titration following standard protocol (Kushida et al., 2008) as part of a split-night study or on a second overnight study. Once a successful PAP titration was completed and reviewed by the sleep physician, orders were sent to a Durable Medical Equipment vendor, who provided home set-up of the PAP machine, education regarding care and maintenance of the machine, and follow-up for mask-related issues and PAP compliance data. Patients were asked to contact their sleep physician one week after the home set-up to verify initiation of PAP treatment and discuss any initial issues related to PAP use. Subsequently, patients were scheduled for a follow-up clinic visit approximately 90 days after initiation of PAP to evaluate treatment progress. The in-lab studies and at-home PAP treatment were managed by board-certified physicians in sleep medicine according to standard care (Epstein et al., 2009; Kushida et al., 2006).

Patients referred for insomnia evaluation or whose primary complaint was difficulty initiating or maintaining sleep were seen by psychologists in the BSM clinic. First, an initial clinical evaluation was conducted to confirm the insomnia diagnosis and evaluate for other sleep disorders, if needed. Following the initial clinic evaluation, patients who endorsed symptoms of insomnia received CBTI following published protocols (Perlis, Jungquist, Smith, & Posner,

2005) and practice guidelines (Morgenthaler et al., 2006), which includes stimulus control, sleep restriction, sleep hygiene education, and cognitive therapy. CBTI was delivered individually by a psychologist Certified in BSM (CBSM) or by a psychology intern under the supervision of a CBSM psychologist.

Cross-referrals between physicians and psychologists were driven by clinical presentation and clinician judgment within the context of routine clinical care without special instructions given to clinicians on when to make referrals. If a patient who presented for OSA evaluation was suspected of having comorbid insomnia, the physician would refer the patient to the BSM clinic for CBTI. Similarly, if a patient who presented with insomnia was suspected of having OSA, the psychologist would refer the patient to a sleep physician for further OSA evaluation and treatment. Cross-referrals could be generated concurrently or sequentially depending on clinical judgment.

Study Participants

Potential research candidates were identified prospectively based upon symptoms reported during routine clinic visits (see procedures above) between December 2010 and October 2012 (see Figure 2 for participant flow). Once a candidate was identified, a research staff member attempted to contact the candidate to conduct a brief screening interview (following the clinic visit or via telephone) and reviewed medical records (if needed) to assess study eligibility. The inclusion criteria for this study were: a) Age $\geq$ 18 years; b) ICSD-2 (American Academy of Sleep Medicine, 2005) criteria for OSA satisfied by at least one clinical symptom on the screening interview and later confirmed by AHI $\geq$ 5 on the diagnostic PSG; and c) ICSD-2 (American Academy of Sleep Medicine, 2005) and Research Diagnostic Criteria (Edinger et al., 2004) for an insomnia disorder satisfied by a complaint of difficulty initiating or maintaining

sleep with significant daytime impairment or distress despite adequate opportunity and circumstance for sleep. Patients were excluded if the initial clinic visit or diagnostic PSG was for suspicion of another sleep disorder (e.g., narcolepsy). This study was approved by the local Institutional Review Board and written informed consent was obtained by the research staff during the in-person screening interview or at the diagnostic PSG.

Study Assessments and Procedures

A baseline assessment was conducted on all participants shortly after enrollment, which consisted of questionnaires and one week of sleep/wake diaries along with data collected from routine medical care (i.e., physical exam and medical history). Questionnaires were administered to gather clinical data, including the Insomnia Severity Index (ISI) (Morin, Belleville, Belanger, & Ivers, 2011), Pre-Sleep Arousal Scale (PSAS) (Nicassio, Mendlowitz, Fussell, & Petras, 1985), Beliefs and Attitudes about Sleep (BAS) (Morin, 1993), Epworth Sleepiness Scale (ESS) (Johns, 1991), Fatigue Severity Scale (FSS) (Krupp, LaRocca, Muir-Nash, & Steinberg, 1989), State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Lushene, 1970), and Beck Depression Inventory (BDI-II) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Prospective sleep/wake diaries were used to assess self-reported sleep parameters along with ratings of sleep quality, daytime sleepiness, and daytime fatigue.

Study patients were re-assessed at follow-up approximately 90 days after the baseline assessment or after they completed the treatment plan recommended by the sleep clinician. The 90-day follow-up time frame was selected as it corresponds to current standards for evaluating progress with PAP treatment (Aloia, Knoepke, & Lee-Chiong, 2010) and allows sufficient time to complete 6 to 8 sessions of CBTI. During the follow-up study visit, patients completed a questionnaire packet and one week of sleep diaries. In addition to the questionnaires described

above, the experience and satisfaction of treatment was collected at follow-up using a 30-item Sleep Treatment Questionnaire (STQ) that was adapted from Parthasarathy and colleagues (Parthasarathy, Haynes, Budhiraja, Habib, & Quan, 2006). The STQ consisted of one section pertaining to sleep apnea treatment, one section for insomnia treatment, and one section for overall treatment experience. For qualitative data, a semi-structured interview was conducted as a focus group consisting of two to four patients, or as individual interviews when scheduling conflicts precluded participation in a focus group. The structured interview consisted of general questions about the treatment experience (e.g., what did you like about your treatment plan?) along with specific questions about PAP and CBT (e.g., Do you feel this treatment made your insomnia/sleep apnea better?). Interview questions were the same regardless of format (group or individual) and were designed to gather qualitative data on the evaluation and treatment process received by the patient. Each interview was audio recorded using a handheld digital recording device (Olympus™ VN-8100PC) and subsequently transcribed verbatim and analyzed using thematic analysis.

Data Analysis Plan

A mixed methods approach was employed to integrate clinical data with patient-centered data for the purpose of exploring the contextual factors associated with interdisciplinary care. To provide a context for interpreting the qualitative data, paired samples t-tests were conducted to examine baseline-to-follow-up changes across each clinical measure. To guard against inflated Type I error, significance was set at $p<.01$ and interpretation of the quantitative data was focused on clinical significance. For qualitative data, thematic analysis was used as the method for coding and deriving themes from the patient interviews following guidelines established by Braun and Clarke (2006). Thematic analysis is a flexible technique used to analyze qualitative

data and is unrestricted by pre-existing theoretical frameworks (Braun & Clarke, 2006). Using an inductive approach, two trained raters (AK and MRC) independently coded each interview and then collated initial codes into overarching semantic themes. These themes were then refined in an iterative process, until consensus was reached between the two raters. Themes of interest included those that pertained to the evaluation and treatment received as part of the interdisciplinary clinic and were distinct but not mutually exclusive. Each theme along with verbal extracts is outlined below with the temporal location of the quote within the text and focus group summarized in Table 3.

RESULTS

A total of 423 patients were approached for participation in this study with 50 patients who provided written informed consent to enroll in this study. After signing the consent, five patients received the diagnostic PSG and did not meet criteria for OSA (AHI < 5), three patients did not complete the diagnostic PSG study, and eight patients did not provide complete baseline data. These 16 patients were excluded from the analyses, yielding a total of 34 patients for the final sample. With regards to treatment sequence, 13 patients received PAP only, 3 received CBTI only, 16 received both PAP and CBTI, and 2 received other treatments outside of the Rush Sleep Disorders Clinic (see Figure 2). Given that the primary aim of this paper was on the process of patient care rather than a comparison of treatment sequences, all analyses were collapsed across treatment sequences. Participant characteristics and baseline medical status are summarized in Table 1.

Clinical Measures

Significant baseline-to-follow-up changes ($p<.01$) in the hypothesized direction were found on total wake time and sleep efficiency on the sleep diaries, PSAS total scores, ISI, and

FSS (see Table 2 for all p values and effect sizes). Using validated cut-off scores for clinical significance (Morin et al., 2011), 31.3% (10 out of 32 patients) no longer met criteria for insomnia (ISI ≥ 11) at follow-up with 12.5% (4 out of 32 patients) in remission (ISI < 8) and 30.0% (9 out of 30 patients) meeting criteria for treatment response (ISI reduction > 7). The percentage of patients who met the clinically significant cutoff for excessive daytime sleepiness (ESS > 10) decreased from 43.8% (14 out of 32) at baseline to 25.8% (8 out of 31) at follow-up. The percentage of patients who met the cutoff for excessive fatigue (FSS ≥ 36) decreased from 81.3% (26 out of 32) at baseline to 68.8% (22 out of 32) at follow-up. Using criteria (BDI ≥ 17) suggested for insomnia patients (Carney, Ulmer, Edinger, Krystal, & Knauss, 2009), the percentage of patients with depression symptoms decreased from 45.5% (15 out of 33) at baseline to 40.6% (13 out of 32 patients) at follow-up. As seen in Table 2, effect sizes across clinical measures were generally above 0.20 (d > 0.20), indicating small to medium effect sizes from baseline to follow-up.

Treatment Experience and Satisfaction

Overall, 86.7% of patients (n=30) were either very satisfied (40%) or satisfied (46.7%) with the treatment they received for their sleep problems. Ratings for OSA treatment (n=27) revealed that 48.1% were very satisfied and 44.4% were satisfied with their treatment. Furthermore, most patients endorsed adequate education (92.6%), understanding of OSA (88.9%), and understanding of OSA risks (85.2%). Those who were prescribed PAP subjectively reported an average of 5.25 hours per night and 5.86 days per week. Ratings for insomnia treatment (n=17) revealed that 43.8% were very satisfied and 37.5% were satisfied with their treatment. Most patients reported adequate education of insomnia (82.4%), understanding of insomnia (76.4%), and understanding of the risks of insomnia (70.5%). Of the

19 patients who received CBTI, the average number of sessions was 3.32 (SD=2.11, range=1-8 sessions). Patients who received CBTI reported using a behavioral strategy 4.64 days per week.

The STQ also revealed quantitative data on the patients' perception of their sleep problem. When asked to identify their primary sleep problem (n=29), 24.1% reported OSA, 24.1% insomnia, and 48.3% reported both. For their first choice of treatment (n=25), 48% reported PAP, 20% reported sleep medication, and 8% reported CBTI while 29.6% reported weight loss as the second choice treatment (n=27). With regards to daytime symptoms (n=30), 30% reported substantial improvement in daytime symptoms and 43.5% reported slightly improved. With regards to nighttime symptoms (n=30), 30% reported substantial improvement and 33.3% reported slight improvement. No patient reported complete resolution of their daytime and nighttime symptoms.

Patient Interviews

Twenty-nine participants completed a follow-up interview either in individual or group format. Nineteen interviews were conducted over the course of this study and each was facilitated by one or two members of the research team. Three themes specific to this comorbid population were identified and are described below, with specific supporting comments from participants reported in Table 3.

Theme 1: Conceptual distinctions between OSA and insomnia. The first theme involved patient's knowledge and their conceptualization of sleep problems. Patients described insomnia as a problem *"fall[ing] asleep",* or one associated with reduced sleep quantity; whereas OSA was typically characterized as a problem *"stay[ing] asleep",* associated with poor sleep quality (see table 3, quotes 1.1-1.5). The distinction was also evident when patients were asked to describe the predisposing and precipitating factors associated with their sleep problem. Patients

described symptoms either specific to insomnia (job stress, racing mind, family issues) or OSA (gender, weight, family history). Other patients referred to factors that were associated with both OSA and insomnia (e.g. genetics). Even when patients were able to distinguish between the two sleep disorders, there was confusion as to why a single "*sleep doctor*" could not address their sleep disturbance as a whole (table 3, quote 1.6).

Theme 2: "Co-morbidity" demands "co-treatment." With the distinction of these two conditions, patients almost unanimously agreed on the importance of treating both conditions *"from a more holistic perspective"* (table 3, quotes 2.1 and 2.2). A number of patients reported insomnia symptoms that were left untreated by PAP, commenting on the difficulty adhering to PAP while lying awake in bed, and that PAP is actually not beneficial if they were not sleeping (table 3, quotes 2.3 and 2.4). According to one individual, residual insomnia actually *"knocks off"* the effectiveness of PAP (table 3, quote 2.5). There was a clear consensus that CBTI had little impact on their OSA symptoms. In contrast, PAP alone was reported to have some positive impact on sleep maintenance but not substantially on sleep onset latency. Patients were *"frustrated"* trying to use PAP, stating residual difficulties with insomnia as the cause (table 3, quote 2.6). Individuals who experienced difficulties using PAP also discussed the negative impact that PAP had on untreated insomnia (table 3, quote 2.7 and 2.8).

Theme 3: Patient preferences for treatment sequence. Patients articulated unique contextual factors that dictated the sequence or order of the treatments. The majority of patients expressed a preference to initiate PAP treatment first, followed by CBTI or another treatment for insomnia. Prioritising PAP was important as some questioned whether a patient would be medically stable enough to *"forgo the machine"* (table 3, quotes 3.1 and 3.2). Others who preferred concurrent treatment or preferred to initiate CBTI first, emphasized how untreated

insomnia could interfere with PAP use and felt that treating insomnia first would improve the effectiveness of PAP. Another contextual factor regarding treatment-decision of sequence was the general dislike and potential stigma associated with PAP treatment. One individual was explicit about his stigma of using PAP, associating the treatment with being almost "*dead*". CBTI on the other hand was not perceived with the same dislike or stigma. Most participants who did not find insomnia symptoms to be alleviated by PAP were open to trying CBTI. Some patients who favored sequential treatment described completing both treatments simultaneously as "*brutal"*. For example, adherence to the stimulus control component of CBTI was considered challenging while wearing a PAP mask (table 3, quote 3.3). These patients suggested adaptations to stimulus control, such as specific instructions on how to remove the mask if the need arises to get out of bed due to sleeplessness. Concurrent treatment also obfuscated some patients' ability to make attributions regarding the effectiveness of each treatment (table 3, quote 3.4). Finally, some patients expressed a preference for treatment planning that included consideration of the patient's individual situation and the complexity of managing multiple medical conditions.

DISCUSSION

The present study is the first to examine the process of care from the patient perspective in an interdisciplinary sleep clinic featuring CBTI and PAP for patients with OSA and comorbid insomnia. The findings revealed important contextual factors regarding the patient experience, which has not been previously reported for this comorbid population. First, patient knowledge about sleep disorders and their consequences was an important factor to those who received treatment. The majority of patients endorsed adequate education about both OSA and insomnia. Consistent with findings by Parthasarathy and colleagues (Parthasarathy et al., 2006; Parthasarathy, Subramanian, & Quan, 2014), patient education appears to be an important aspect

of high quality patient care in accredited sleep centers. However, education about the individual sleep disorders may not necessarily enable the individual to form accurate conceptualizations of the co-morbidity between insomnia and OSA, suggesting the need for more specific adaptations of patient education for this comorbid group. Qualitative data from patient interviews revealed that patients' distinction between OSA and insomnia involved sleep disturbance phenotypes (onset vs. maintenance) or the sleep quality/quantity dimension. Specifically, insomnia was considered a problem occurring at sleep onset while OSA was considered a problem with sleep maintenance. This distinction is interesting given that sleep onset insomnia has been shown to persist despite PAP treatment (Bjornsdottir et al., 2013). Even when patients were able to distinguish between the two sleep disorders, there was confusion as to why a single "sleep doctor" could not address their sleep disturbance as a whole, even though they believed in treating both conditions. Thus, better integration and more specific education about distinctions between the symptoms of OSA and insomnia could improve patient care.

Second, important contextual factors related to the delivery of PAP and CBTI were revealed in this study. Several patients reported difficulty and frustration of using PAP while lying awake in bed, indicating that untreated or residual insomnia reduced the effectiveness of PAP, an experience that is consistent with previous reports from the literature (Bjornsdottir et al., 2013; Pieh et al., 2013; Wallace et al., 2013; Wickwire et al., 2010). However, some patients reported that the use of PAP alone led to improvements in sleep maintenance but not for sleep onset. One noteworthy challenge involves the difficulties of following the stimulus control instructions of getting out of bed while using PAP. It might not be clear to patients whether it is more important to continue wearing the mask or to get out of bed and go to another room, as instructed. Therefore, the delivery of CBTI and PAP in an interdisciplinary sleep clinic should

consider adaptations or modifications of instructions that account for the interaction between the two sleep disorders and their treatments. For example, clinicians should discuss a specific plan with patients regarding what to do with PAP machines as part of delivering stimulus control instructions, or consider implementing stimulus control after treatment with PAP is stabilized.

Third, several specific considerations related to treatment decision-making were unveiled for this comorbid group. The STQ revealed that 48% rated PAP as their first choice of treatment while only 8% endorsed CBTI as the first choice of treatment. This was corroborated by patient interviews where most preferred PAP treatment for OSA as the first line treatment while CBTI was seen with less urgency as an adjunct or secondary treatment. Interestingly, treatment preference was not directly related to patients' primary concern, considering that 48.3% of patients reported both OSA and insomnia as the primary problem and 21.4% of patients reported either OSA or insomnia. Furthermore, these quantitative ratings in treatment preferences did not appear to reflect the negative perception of PAP treatment compared to CBTI that was reported in the patient interviews. Thematic analysis of patient interviews also revealed that patients based treatment decisions on physician recommendations, perception of OSA severity, or feeling over-burdened by experiencing both treatments concurrently. Several participants expressed greater satisfaction with their care when their treatment plan was individualized and took account of the complexities of having both OSA and insomnia. This indicates that patients could benefit from shared decision-making that includes a discussion about the expectations of treatment, patient preferences, and the capacity for treatment.

Overall, patients who were engaged in treatment reported positive clinical effects on nocturnal symptoms and daytime functioning that are similar to or slightly lower than those reported for CBTI (Irwin, Cole, & Nicassio, 2006; Morin, Culbert, & Schwartz, 1994; Smith et

al., 2002) and PAP (Balk et al., 2011; Engleman, Martin, Deary, & Douglas, 1994). Over 86% of patients expressed overall satisfaction with the treatment they received with high rates of satisfaction for each modality of treatment. However, global measures from the STQ and clinical significance criteria revealed a more modest clinical profile. No patient reported complete resolution of their sleep problems with 33.3% reporting no change in nighttime symptoms and 23.3% reporting no change in daytime symptoms. At follow-up, only 12.5% of the patients were in remission for insomnia and only 30% met criteria for treatment response, with 68.8% of patients still reporting excessive fatigue. Notably, the mean number of CBTI sessions attended was only 3.32, which is suboptimal according to recommendations for CBTI delivery (Perlis et al., 2005) and might account for the low treatment response on insomnia outcomes. Continued efforts are needed to achieve better outcomes across the full range of nighttime, daytime, and emotional issues that are prominent in this population.

Several limitations should be noted in this observational study. First, treatments were delivered according to standard care using clinical judgment and not protocol-driven as would be done in a randomized controlled trial. This led to variability in treatment plans, including the combination and sequence of treatments, as well as variability in clinic attendance and completeness of follow-up data. There was also a potential for response bias, as those who were not satisfied with treatment or did not perceive benefits might not have returned to the clinic and provided follow-up data. Therefore, the outcome and satisfaction data should be interpreted with caution. Second, no control group was available so baseline-to-follow-up changes cannot be attributed specifically to the treatments provided. Third, this was a relatively small sample size, which might not generalize to other sleep clinics. Fourth, our sleep clinic does not routinely score respiratory event related arousals (RERAs), which could have an impact on diagnosis and

treatment in this population. Finally, the limitations of thematic analysis should be acknowledged, including subjective interpretations of patient responses and the potential for investigator bias in identifying themes.

Despite these limitations, the present findings serve as a starting point towards tailoring treatment delivery and optimizing clinical resources in sleep clinics for patients with OSA and comorbid insomnia. Based on our findings that traditional diagnostic categories (i.e., OSA, insomnia) might create confusion for patients with multiple sleep disorders, one proposal would be to use a dimensional approach to assessing and treating patients who have comorbid sleep disorders. Such an approach could use patient-reported ratings and clinical findings across symptoms (or functional domains) to generate a profile based on the degree to which each symptom (or area of dysfunction) is present. This profile, similar to Bussye's (2014) dimensional profile of sleep health, could then be used to develop a personalized treatment plan matching the most urgent or intense symptoms as perceived by patients with tailored treatment components (e.g., sophisticated PAP devices better suited for patients with comorbid insomnia, stimulus control modified for PAP use). Furthermore, patients can be introduced to a team-based approach with providers (i.e., physicians, psychologists, nurses) who have relevant expertise in delivering these tailored treatments, which can encourage shared decision-making based on treatment preferences and concerns. This dimensional and team-based approach could serve as an innovative model for interdisciplinary sleep clinics and an area for future research.

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Table 1. Baseline Patient Characteristics.

Age, mean (SD)	54.11 years (13.27)
Gender, %	61.8% female, 38.2% male
Ethnicity, %	94.1% Non-Hispanic, 5.9% Hispanic
Race, %	47.1% White, 47.1% Black, 5.9% Asian
Relationship Status, %	44.1% married/engaged, 35.3% single, 20.6% divorced/separated/widowed
Education, mean (SD)	15.46 years (3.79)
Comorbid medical conditions, mean (SD)	7.0 (4.5)
HEENT, % ≥ 1 condition	38.3%
CV, % ≥ 1 condition	64.7%
Respiratory, % ≥ 1 condition	38.2%
GI, % ≥ 1 condition	55.9%
GU, % ≥ 1 condition	20.6%
Musculoskeletal, % ≥ 1 condition	70.6%
Endocrine, % ≥ 1 condition	61.8%
Hematological, % ≥ 1 condition	29.4%
Psychiatric, % ≥ 1 condition	64.7%
Neurological, % ≥ 1 condition	20.6%
Rheumatologic, % ≥ 1 condition	8.8%
Number of medications, mean (SD)	8.2 (5.1)
Number of sedating/alerting medications, mean (SD)	2.1 (1.6)
BMI, mean (SD)	37.59 (10.93)
AHI, mean (SD)	31.57 (35.26)
OSA Severity	Mild (n=13), Moderate (n=12), Severe (n=9)
PAP pressure, mean (SD)	12.40 cm H_2O (5.86)

Note. Medical conditions were reviewed by the sleep physicians (MP, MIC, EA) and categorized based on reported past medical history or inferred from medication use and medications were reviewed and categorized according to medical indication. Each category under comorbid medical conditions represents the percentage of patients with at least one comorbid condition in that category. HEENT = Head, Eyes, Ears, Nose, Throat, CV = cardiovascular, GI = gastrointestinal, GU = genitourinary, BMI=Body Mass Index, AHI = Apnea-Hypopnea Index, PAP = positive airway pressure. For OSA severity, mild = AHI $\geq$ 5 but < 15, moderate = AHI $\geq$ 15 but < 30, severe = AHI $\geq$ 30.

Table 2. Baseline to Follow-up Data

Measures	Baseline		Follow-up					
	M	SD	M	SD	df	*t*	*p*	*d*
Sleep Diary Data								
SOL (min)	56.26	66.66	32.45	25.71	28	-2.09	.046	-.35
WASO (min)	57.43	53.83	42.70	45.02	27	-2.72	.081	-.42
TWT (min)	115.30	79.12	74.56	51.78	27	-3.30	.003	-.53
TST (min)	395.35	109.96	417.04	118.51	27	1.72	.097	.24
TIB (min)	505.35	89.75	493.06	104.17	28	-0.73	.474	-.15
SE (%)	77.85	13.23	84.45	11.43	27	3.20	.003	.52
NWAK	2.39	1.07	2.17	1.16	28	-1.81	.081	-.20
Daytime Alertness	44.61	20.50	53.77	20.88	29	2.09	.046	.34
Pre-Sleep Arousal Scale (Total)	42.12	12.27	36.19	10.57	30	-2.90	.007	-.46
Cognitive	23.45	6.67	20.50	7.07	30	-2.69	.012	-.39
Somatic	18.67	7.02	15.69	5.32	30	-2.82	.008	-.49
Insomnia Severity Index	17.94	5.47	14.50	5.78	29	-3.42	.002	-.55
Beliefs and Attitudes about Sleep	134.79	44.42	124.34	41.63	31	-1.60	.120	-.27
State-Trait Anxiety Inventory	47.71	13.67	44.58	13.14	31	-2.42	.021	-.37
Beck Depression Inventory	17.58	11.22	16.50	13.27	30	-0.71	.484	-.13
Epworth Sleepiness Scale	9.97	5.62	8.10	5.08	29	-2.61	.014	-.45
Fatigue Severity Scale	45.75	10.87	40.94	12.46	29	-3.35	.002	-.61

Note. SOL = sleep onset latency; WASO = wake after sleep onset; TWT = total wake time, TST = total sleep time; TIB = time in bed; SE = sleep efficiency; NWAK = Number of Awakenings. Daytime alertness is rated from 0 (very sleepy) to 100 (very alert), with lower numbers reflecting greater levels of sleepiness and higher numbers rating greater levels of alertness.

Table 3. Patient Interview Themes and Responses

Theme	Verbal extract	Patient Details	Interview/Fo
1. Conceptual distinctions between OSA and insomnia	*1.1"with insomnia you are going to want to fall asleep. But also with using sleep apnea [CPAP], you want to try to find a way to stay asleep."*	**Male, 42 yr, Treatment: PAP + CBTI**	**Interview 1, participant I**
	1.2"My sense is that they are not very much related, you know that the awaking from the episodes of apnea were that, they were not part of the insomnia, the bad sleep habits or whatever."	**Male, 68 yr, Treatment: PAP → CBTI**	**Interview 8,**
	1.3"I didn't know if they [physicians] knew that I had insomnia, I didn't know if I [emphasis] knew I had insomnia [...] I knew I wasn't sleeping. But I had related it to be sleep apnea, not insomnia."	**Male, 63 yr, Treatment: PAP → CBTI**	**Interview 5,**
	1.4 "I'm never conscious like 'now I have sleep apnea', no, I sleep through sleep apnea or I wake up and not knowing it was caused by sleep apnea. So [...] there is probably less interruptions than there was before [insomnia treatment]. So I pose that is evidence that [insomnia treatment] is working."	**Male, 56 yr, Treatment: PAP + CBTI**	**Interview 2,**

	1.5"They weren't treating me for both. We are finding out that I need (stress) treatment for both. Ah when I first came, it was just for the apnea. Now we are leaning more towards the insomnia."	**Female, 52 yr, Treatment: PAP → CBTI**	**Interview 14**
	1.6 "why are there two different[sleep doctors] I understand why there is (sic) two different disciplines [...]it seemed to me that having a sleep doctor...would understand both sides of the equation."	**Male, 46 yr, Treatment: PAP only**	**Interview 1,**
2. "Co-morbidity" demands "co-treatment"	*2.1 "I think that you should approach [treatment] from a more holistic perspective, rather than siding each individual discipline. Because overall, you are treating the patient, right; and so you know, this person has this set of problems."*	**Male, 46 yr, Treatment: PAP only**	**Interview 1,**
	2.2 "I would say try [the treatments] both at the same time. Because one has to get to complement the other one."	**Male, 68 yr, Treatment: PAP → CBTI**	**Interview 8,**
	2.3 "I believe its [CPAP] function is to make sure that I am breathing while I am sleeping. Well it's not about breathing while I'm sleeping at this point. It's about getting to sleep and staying asleep."	**Female, 52 yr, Treatment: PAP → CBTI**	**Interview 14**
	2.4 "I needed most help, I think, with insomnia. Is […], if you're not falling asleep, the CPAP is not going to do anything for you. From my understanding anyway, it doesn't really help you when you are awake."	**Male, 56 yr, Treatment: PAP + CBTI**	**Interview 2,**

	2.5 "the machine is very helpful, but with the insomnia, it just kind of knocks it off."	**Female, 39 yr, Treatment: CBTI → PAP**	**Interview 12**
	2.6 "I didn't see any results, and I think it was the insomnia that made me more frustrated with the CPAP machine."	**Male, 56 yr, Treatment: PAP + CBTI**	**Interview 2,**
	2.7 "Now with the CPAP machine, when I do [emphasis] go sleep, it has helped me with you know like restful sleep. But since I do have the insomnia, the thing is I've got to train myself to do go to bed, to use the CPAP."	**Female, 67 yr, Treatment: PAP + CBTI**	**Interview 4,**
	2.8 "I think it might be a little worse [...]. I wake up in the middle of the night. I don't know if I'm waking up because of the air is (sic) blowing in my eyes, or if I'm waking up by myself and I am noticing that I have air blowing in my eyes."	**Female, 37 yr, Treatment: PAP only**	**Interview 10**
3. Patient preferences for treatment sequence	*3.1 "I was just wondering if the decision the physician would have to make, if the person is physically healthy enough for (sic) forgo the machine."*	**Male, 56 yr, Treatment: PAP + CBTI**	**Interview 2,**
	3.2 "If [the sleep apnea] is mild , then do insomnia [treatment] first. Because the insomnia is teaching you how to go to sleep. And with sleep apnea, it's like staying asleep and kind of breathing and continue breathing."	**Male, 42 yr, Treatment: PAP + CBTI**	**Interview 1,**

	3.3 "it would have been better to try to treat the insomnia first, and then introduce the CPAP sometime later [...] but getting out of bed because I'm not asleep yet, in that situation [concurrent treatment], was brutal."	**Male, 56 yr, Treatment: PAP + CBTI**	**Interview 2,**
	3.4 "I doubt [that insomnia treatment had any influences on sleep apnea], but I don't know how to separate that out since I never sleep without the CPAP."	**Male, 67 yr, Treatment: PAP → CBTI**	**Interview 13**

Note: The quotes presented in this table were selected as representative data for each theme. Matching each quo information about the patient's gender, age, treatment (and order) received, the interview number, lines in the tra selected from, and the participant identification (ID) number. For treatment received, PAP + CBTI = received bo concurrently; PAP → CBTI = received PAP first, followed by CBTI second; CBTI → PAP = received CBTI firs second.