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EDITORIALS

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What Do We/They Want to Know?

Leslie C. Dort, DDS, Diplomate, ABDSM, Editor-in-Chief *Journal of Dental Sleep Medicine*

Calgary, Alberta, Canada

Dental sleep medicine clinicians and researchers had the opportunity at the recent AADSM annual meeting to hear leading researchers give state-of-the-art lectures on the latest developments both oral appliance therapy and related topics. Dental sleep medicine clinicians look to these meetings and this journal to help guide their clinical care of patients. The dental sleep medicine audience tends to appreciate, more than other dental audiences, the need for evidence to provide the foundation of clinical practice. It is an audience hungry for evidence. But it is not the only audience with questions.

I recently had the honor of giving a presentation on oral appliance therapy at the APSS meeting in Seattle. The audience was primarily sleep physicians and their questions about oral appliance therapy proved to be very informative. Below is a list of representative questions asked by sleep physicians.

1. When I prescribe oral appliance therapy what appliance should I tell my patients to ask their dentist to provide?
2. What about the orthodontic changes that result from the use of oral appliances, can anything be done to prevent them, how serious are they?
3. Can children have oral appliance therapy?
4. How much does it cost?
5. How do we as physicians know what dentists to collaborate with?
6. How do a find a dentist who works with the government funding programs?
7. What if a patient with severe OSA refuses CPAP- what will a dentist tell them?
8. What about truck drivers and compliance- can they just put their appliances in a water bath to mimic compliance?
9. How do I approach a dentist- I know nothing about teeth and oral appliances?

Some of these questions have been addressed in the recent AASM/AADSM joint guidelines, published in this issue of *Journal of Dental Sleep Medicine*[1] and the July 2015 issue of *Journal of Clinical Sleep Medicine*. The guidelines for the first time address the issue who may be qualified to practice dental sleep medicine. The guidelines also address the roles of the physician and dentist in diagnosis, follow-up sleep testing and long term follow-up. Other questions require one-to-one networking. It is obvious that there are physicians eager to collaborate and dentists need to get out there and find them.

Other questions may be answered by the development and publication of practice protocols. However, many questions require research, years of research and data collection. It is my hope that through this journal we will be able to help disseminate both new research findings and reviews to continue to help answer these questions.

CITATION

Dort LC. What do we/they want to know? *Journal of Dental Sleep Medicine* 2015;2(3):65.

REFERENCE

1. Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, Chervin RD. Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: an update for 2015. *Journal of Dental Sleep Medicine* 2015;2:71–125.

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Dr. Dort is Editor-in-Chief of *Journal of Dental Sleep Medicine*.

ORIGINAL ARTICLES

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A Brief Report on the Development of the Usability of Sleep Apnea Equipment–Oral Appliance (USE-OA) Questionnaire: A Pilot Study

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Study Objectives: To develop a questionnaire for measuring human factors (usability) associated with oral appliance use and to assess the feasibility of administering the questionnaire to patients with obstructive sleep apnea in a clinic setting.

Methods: We developed the 11-item Usability of Sleep Apnea Equipment–Oral Appliance (USE-OA) Questionnaire by adapting items from a published questionnaire that had been developed to assess human factors associated with positive airway pressure device use. Then we distributed the USE-OA to patients at a university dental clinic between January and July 2014. We evaluated our survey methods qualitatively, calculated the response rate, and assessed completeness and response patterns of the USE-OA.

Results: Our formative evaluation revealed that the questionnaire was easy to distribute and administer in a clinic setting. Our response rate was 23%. A majority of respondents gave favorable usability ratings, and a small number of respondents gave unfavorable usability ratings.

Conclusions: The USE-OA questionnaire can be easily administered in a dental clinic setting. Additional studies conducted in high-volume sleep oral appliance clinics are needed to assess the psychometric properties of the USE-OA and to compare the results of the USE-OA to direct observation of patients getting their oral appliance ready for use and cleaning their oral appliance.

Keywords: sleep apnea syndromes, orthodontic appliances, human engineering

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Oral appliances (OA) such as mandibular advancement devices are a common form of therapy for obstructive sleep apnea (OSA). Studies show that OAs can improve the severity of OSA (i.e., decrease apnea-hypopnea index) and symptoms of OSA such as excessive daytime sleepiness.[1] Many patients accept and adhere to OA therapy, but unfortunately, nonacceptance and nonadherence are also common.[2] Patients may reject therapy due to excessive salivation, oral lesions, malocclusion, or worsening of temporomandibular joint pain.[2] Regular use of OAs requires behavioral modification—adoption of the therapy into the patient's nightly sleep regimen. Similar to other health behaviors, factors such as lack of knowledge about OSA and OAs, negative attitude towards OAs, low expectations for treatment, lack of social support, and low self-confidence for using OAs are possibly barriers to adherence.[3]

Human factors (i.e., usability of equipment or other treatment methods) may also contribute to nonadherence to OSA therapies, including OAs. Human factors is "an applied science that takes research about human abilities, limitations, behaviors, and processes and uses this knowledge as a basis for the design of tools, products, and systems."[4] These factors represent concepts such as ease of learning, ease of operating the therapeutic device, and ease of remembering how to use it, as well as patients' overall satisfaction with the device-user interface.[5,6] "Applying human factors principles leads to designs that are safer, more acceptable, more comfortable, and more effective for accomplishing their given tasks."[4]

Few studies have assessed human factors in the context of OSA therapy. A recent pilot survey found that 8% of positive airway pressure device users strongly disagreed with the statement, "When I first got my current equipment, I easily learned how to get it ready for use."[7] In this same study, 20% of respondents reported difficulty getting their equipment ready for use in the past 30 days.[7] Most studies, however, have limited assessments of human factors to asking patients about overall satisfaction with the device.[9–12]

In general, assessment of human factors may occur during either of the two stages of a medical device's approval life cycle: pre-market and post-market. During the pre-market approval process, the Food and Drug Administration requires manufacturers to present human factors data. These data focus primarily on the impact of human factors on the safety and effectiveness of the device.[5] Post-market assessments of human factors occur ad hoc (e.g., filing incident reports[8]), despite the potential broad impact of human factors on adherence to therapy and sales of the device. This may be due to the rudimentary infrastructure and lack of tools to date for conducting wide-scale human factors surveys. Survey instruments to conduct such research are not available. Only survey items to measure overall satisfaction and preference for OA therapy have been tested.[9–12]

The purpose of this study was to develop a questionnaire to measure human factors associated with OA use among patients with OSA. This questionnaire may be useful clinically to assess human factors that contribute to nonadherence.

METHODS

USE-OA Questionnaire Development

To develop the USE-OA, we adapted the general usability items from the Usability of Sleep Apnea Equipment–Positive Airway Pressure (USE-PAP), which was developed with

Table 1—Participant characteristics (n = 10).

Item	Frequency (%)
Age (years)	
18–29	0 (0%)
30–39	0 (0%)
40–49	0 (0%)
50–59	2 (20%)
60–69	6 (60%)
70 years or older	1 (10%)
Missing	1 (10%)
Do you know the name of your dental appliance	
No	3 (30%)
Yes	6 (60%)
Missing	1 (10%)
How long have you been using current dental sleep appliance?	
Less than 1 year	7 (70%)
1–5 years	2 (20%)
More than 5 years, but fewer than 10 years	1 (10%)
10 years or longer	0 (0%)
Other than your current dental sleep appliance, have you ever used any other sleep apnea appliances or equipment at home (not counting temporary equipment given to you for testing purposes)?	
No	4 (40%)
Yes	4 (40%)
Missing	2 (20%)

rigorous survey instrument methodology consisting of a literature review of human factors survey instruments, in-depth interviews with patients, a technical advisory panel, cognitive interviews, and a pilot survey among PAP users.[7] Similar to the USE-PAP items, the USE-OA human factors items are aimed at measuring the following constructs: learnability, memorability, effectiveness (ease of patient getting the OA ready for use, not clinical effectiveness), efficiency, feedback from the OA that it is working, and overall satisfaction. For each of the 9 human factors items, respondents are asked to rate their agreement with each statement and are provided the following response options: strongly agree (5), agree (4), neither agree nor disagree (3), disagree (2), and strongly disagree (1). Two additional items were developed to assess the frequency of difficulty getting the OA ready for use and cleaning the OA in the past 30 days. For these items, the response options are the following: no days (4), some days (3), most days (2), everyday (1), or doesn't apply to me (–6). The last option is provided for respondents who have not used their OA within the past 30 days or who never clean their OA. The questionnaire was revised iteratively (formatting, phrasing) prior to distributing it to clinic patients, based upon feedback from sleep clinical and research staff at our institution. The final USE-OA consisted of 11 items that assessed human factors associated with OAs.

Feasibility Testing

From January 2014 to July 2014, we conducted a feasibility survey at a university dental clinic that treats patients with OSA to test the USE-OA questionnaire items and our research methods for conducting a human factors survey. In addition to the USE-OA, we included in our survey instrument items to collect information about the participant's age group, the brand name of the OA, the length of use of the OA, and previous attempts at other OSA treatments. We also included an open-ended item that asked participants to describe any experiences using current or past OSA treatments.

Patients who checked in to the clinic were provided a study information sheet, a survey cover sheet (which indicated that the survey would take 2 to 3 minutes to complete), the survey instrument, and a blank envelope. Patients who were interested in participating in the survey self-screened for eligibility by completing 2 items at the top of the questionnaire that confirmed that the participant was aged ≥ 18 years and was a current or previous sleep OA user. Patients who screened eligible completed the questionnaire and returned it in a sealed envelope to their dental provider. Patients who were ineligible or who opted out of participating had the option to return a blank questionnaire in the sealed envelope or not to return any envelope. The envelopes were given to their dental provider, who placed the envelope in a collection box, which was located in an area of the clinic accessible only to clinic staff. Responses were entered into a Microsoft Access 2010 database. The study was approved by the institutional review board at the University of California, Los Angeles.

Analyses

During the feasibility testing, we conducted a formative evaluation of the survey procedures. Descriptive statistics to characterize the completeness (missing values) of the questionnaires and variation in responses were summarized to describe central tendency (Microsoft Excel 2010). We also reviewed questionnaires for handwritten comments and responses, which may be present when questionnaire items are unsatisfactory to participants and can ultimately, inform survey revision.

RESULTS

Based on informal feedback from the dental clinic staff, the questionnaire was easy to distribute and administer in an office setting.

Ten completed surveys were available for review and analysis (response rate 23%). Participant characteristics are summarized in Table 1. Two participants (20%) indicated difficulty getting their OA ready for use (1 individual indicated "some days" and 1 individual "every day"). No participants responded that they have difficulty cleaning their OA. Table 2 provides the responses to the human factors items. Most participants gave favorable usability rating, either strongly agreeing or slightly agreeing with the human factors statements. However, one participant gave unfavorable ratings of the ease of getting the OA ready for use and of knowing when the OA is working properly. The questionnaire did not contain any comments written in the margins.

DISCUSSION

To our knowledge, the USE-OA is the first questionnaire to broadly assess patient-reported human factors (usability) associated with OA use. This brief report describes the items

Table 2—Mean and median responses to USE-OA items (n = 10).

Item	Mean (SD)	Median (Interquartile Range)
When I first got my current appliance, I easily learned how to get it ready for use.	4.7 (0.48)	5.0 (4.0, 5.0)
I could remember how to get my appliance ready for use, even if I did not use it for a month.	4.8 (0.42)	5.0 (4.7, 5.0)
I can successfully get my appliance ready for use without assistance.	5.0 (0.00)	5.0 (5.0, 5.0)
I can quickly get my appliance ready for use.	4.7 (0.95)	5.0 (5.0, 5.0)
I know when my appliance is working properly.	4.6 (0.97)	5.0 (4.7, 5.0)
I can quickly remove my appliance from my mouth.	4.8 (0.42)	5.0 (4.7, 5.0)
My appliance is easy to clean.	4.9 (0.32)	5.0 (5.0, 5.0)
My appliance is convenient for traveling.	4.9 (0.32)	5.0 (5.0, 5.0)
I would recommend this appliance to a friend who has sleep apnea.	4.5 (0.97)	5.0 (4.0, 5.0)

in the questionnaire and the feasibility of administering it. We found that the USE-OA is easy to administer and because of its short length, has the potential to be distributed to a large number of OA users and may identify the subset of patients with usability challenges. As expected, most respondents gave favorable usability ratings regarding their OAs, but as is the case for PAP usability,[7] not every respondent gives the highest ratings. Additional surveys conducted in high volume OA clinics are needed to formally assess the psychometric properties of the USE-OA.

As more evidence emerges on the effectiveness of various types of OAs for OSA treatment and more patients turn to OA for OSA treatment, post-market assessments of human factors associated with OA devices are needed. These assessments should be systematic, large-scale, quantifiable, and accessible, and results of these surveys should be available to patients and providers to enable them to identify devices that are most suitable for patients and to provide signals to manufacturers about the types of improvements that are needed to enhance usability. To achieve these assessments, questionnaires such as the USE-OA are needed. We found that the USE-OA could be quickly completed by patients in the waiting area of a clinic.

Comparisons of human factors between PAP and OA are also needed. Clinical trials have examined general satisfaction or general preference for OA versus PAP,[2] but the human factors literature suggests that other constructs are also important.[6,13,14] Together, the USE-OA and the USE-PAP have the potential to achieve these comparisons, because the general items from the USE-OA align closely with the general items from the USE-PAP. In addition to the self-administered surveys, which are relatively inexpensive to conduct and can be used in a large population, direct observation of patients performing OA- and PAP-related tasks should be conducted to compare the usability of OAs and PAPs.

The main limitation of this study is the small sample size, which is common in feasibility studies. Patients at a university dental clinic may not be representative of other clinic populations—feasibility issues that were not detected in this study could arise in other samples. Inferences about human factors were not the aim of the study; rather, the study was performed to identify major flaws in the questionnaire and the survey methods and to inform a larger pilot study, which will assess the psychometric properties of the instrument and provide descriptive statistics on the usability of OAs.

In conclusion, we tested the feasibility of adapting items from an existing questionnaire that measures PAP usability to form the USE-OA. Additional testing is needed to assess the reliability and validity of this new instrument. The USE-OA assesses human factors-usability constructs that are commonly queried in other industries, and may prove useful in the evaluation of medical devices used in the treatment of OSA.

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SPECIAL ARTICLES

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Clinical Practice Guideline for the Treatment of Obstructive Sleep Apnea and Snoring with Oral Appliance Therapy: An Update for 2015

An American Academy of Sleep Medicine and American Academy of Dental Sleep Medicine Clinical Practice Guideline

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Introduction: Since the previous parameter and review paper publication on oral appliances (OAs) in 2006, the relevant scientific literature has grown considerably, particularly in relation to clinical outcomes. The purpose of this new guideline is to replace the previous and update recommendations for the use of OAs in the treatment of obstructive sleep apnea (OSA) and snoring.

Methods: The American Academy of Sleep Medicine (AASM) and American Academy of Dental Sleep Medicine (AADSM) commissioned a seven-member task force. A systematic review of the literature was performed and a modified Grading of Recommendations Assessment, Development, and Evaluation (GRADE) process was used to assess the quality of evidence. The task force developed recommendations and assigned strengths based on the quality of the evidence counterbalanced by an assessment of the relative benefit of the treatment versus the potential harms. The AASM and AADSM Board of Directors approved the final guideline recommendations.

Recommendations:

1. We recommend that sleep physicians prescribe oral appliances, rather than no therapy, for adult patients who request treatment of primary snoring (without obstructive sleep apnea). (STANDARD)
2. When oral appliance therapy is prescribed by a sleep physician for an adult patient with obstructive sleep apnea, we suggest that a qualified dentist use a custom, titratable appliance over non-custom oral devices. (GUIDELINE)
3. We recommend that sleep physicians consider prescription of oral appliances, rather than no treatment, for adult patients with obstructive sleep apnea who are intolerant of CPAP therapy or prefer alternate therapy. (STANDARD)
4. We suggest that qualified dentists provide oversight—rather than no follow-up—of oral appliance therapy in adult patients with obstructive sleep apnea, to survey for dental-related side effects or occlusal changes and reduce their incidence. (GUIDELINE)
5. We suggest that sleep physicians conduct follow-up sleep testing to improve or confirm treatment efficacy, rather than conduct follow-up without sleep testing, for patients fitted with oral appliances. (GUIDELINE)
6. We suggest that sleep physicians and qualified dentists instruct adult patients treated with oral appliances for obstructive sleep apnea to return for periodic office visits—as opposed to no follow-up—with a qualified dentist and a sleep physician. (GUIDELINE)

Conclusions: The AASM and AADSM expect these guidelines to have a positive impact on professional behavior, patient outcomes, and, possibly, health care costs. This guideline reflects the state of knowledge at the time of publication and will require updates if new evidence warrants significant changes to the current recommendations.

Keywords: obstructive sleep apnea, snoring, oral appliance, mandibular advancement, positive airway pressure

Citation: Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, Chervin RD. Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: an update for 2015. *Journal of Dental Sleep Medicine* 2015;2(3):71–125.

SUMMARY

Since the publication of the initial position statement by the American Academy of Sleep Medicine (AASM) in 1995, the clinical use of oral appliances (OAs) for the treatment of snoring and obstructive sleep apnea (OSA) has markedly increased. The most recent AASM practice parameters on the treatment of snoring and OSA with oral appliances was published in 2006 as "Practice Parameters for the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances: An Update for 2005" with the accompanying systematic review paper "Oral Appliances for Snoring and Obstructive Sleep Apnea: A Review." Since these publications, the scientific literature on OAs has grown considerably, particularly related to clinical outcomes after use of OAs. The purpose of this guideline is therefore to replace the recommendations in the 2006 guideline for the use of OAs in the treatment of OSA and snoring.

Methods

To develop this guideline, the AASM and American Academy of Dental Sleep Medicine (AADSM) commissioned a task force of seven members, three sleep medicine physicians and two dentists, with expertise in the use of OAs, and two

AASM research staff members experienced in guideline development. None of the task force members had any conflicts that would preclude participation in this effort. Eleven PICO (patient, population or problem, intervention, comparison, and outcomes) questions were developed based on both the questions raised in the 2006 AASM review paper and practice parameter and review of systematic reviews, meta-analyses, and guidelines published since then (Table 1). The AASM Board of Directors approved the final list of PICO questions before the targeted literature search was performed.

The literature search was performed by the AASM research staff using the PubMed and Embase databases. Though the search yielded all types of articles with various study designs, for most PICO questions the analysis was limited to only randomized controlled trials (RCTs). The RCTs that were cited in the 2006 AASM review paper and 2006 practice parameter paper were included for data analysis if they met the study inclusion criteria. For PICO questions 7 and 11, due to lack of RCTs, we relied on prospective observational studies. The PubMed database was searched from January 1, 2004, through July 31, 2012, and was updated again on February 28, 2013, to capture the latest literature. A total of 324 citations were identified in PubMed and supplemented by pearling. A total of 53 citations were identified in Embase, yielding a total of 377 citations from both databases.

Meta-analysis was performed with Review Manager 5.2 software to compare various types of OAs used to treat snoring and OSA. Oral appliances were categorized into the following types: custom, titratable; custom, non-titratable; non-custom, titratable; and non-custom, non-titratable. Meta-analysis was performed for each PICO question by pooling data across studies for each outcome measure. All analyses were performed using the random effects model. The result of each meta-analysis is shown as a forest plot.

The assessment of evidence quality was performed according to a modified Grading of Recommendations Assessment, Development, and Evaluation (GRADE) process. The final assessment, as defined in Table 3, was determined for each treatment and outcome measure. The results are reported as evidence profiles for each PICO question that include the number of studies, study design, limitations, inconsistency, indirectness, imprecision, and other considerations that went into determining the quality of evidence for each outcome of interest. The task force then developed recommendations for the efficacy of OA treatment for snoring and OSA. Strengths of recommendation were assigned to these statements based on the quality of the evidence and counterbalanced by an assessment of the relative benefits of the treatment versus the potential risks as delineated in Table 4.

This guideline refers to a "qualified dentist" as the dental provider of choice to provide oral appliance therapy. The successful delivery of oral appliances requires technical skill, acquired knowledge, and judgment regarding outcomes and risks of these therapies. The need to append the word "qualified" stems from two things: (1) all of the studies conducted to evaluate the efficacy and risks of oral appliances were conducted by dentists with considerable experience in dental sleep medicine, and (2) the unfortunate fact that training in dental sleep medicine is uncommon. Therefore, not all dentists have the training or experience required to deliver knowledgeable care, and application of the literature to practice dental sleep medicine.

The American Academy of Dental Sleep Medicine (AADSM) is one of several organizations that has begun to address this issue over the past decade via the development and delivery of educational programs in dental sleep medicine along with the development of a certifying examination in dental sleep medicine that is now administered and maintained by the American Board of Dental Sleep Medicine (ABDSM). As physicians diagnose and subsequently refer patients with OSA to select dentists to evaluate for delivery of oral appliance therapy, they should seek qualified dentists who have a valid state license and proof of liability coverage and possess additional training or experience in this area of care. Although not all-inclusive, desirable qualifications include that the dentist have at least one of the following: certification in dental sleep medicine by a non-profit organization, designation as the dental director of a dental sleep medicine facility accredited by a non-profit organization, or a minimum of 25 hours of recognized continuing education in dental sleep medicine (e.g., American Dental Association Continuing Education Recognition Program [ADA CERP] or Academy of General Dentistry Program Approval for Continuing Education [AGD PACE]) provided by a dental sleep medicine focused non-profit organization or accredited dental school in the last two years.

OSA is a chronic disorder and therefore would be best diagnosed and followed by a sleep physician in cooperation with any other healthcare providers the patient may be going to for treatment (their primary care physician, a qualified dentist, ENT, etc.). For the purposes of this guideline, a sleep physician is defined as a physician who is either sleep board-certified or sleep board-eligible. A multicenter, prospective, comparative effectiveness study showed that board-certified sleep physicians and accredited centers improved patient-centered outcomes for OSA patients. Also, most of the RCTs that were reviewed to develop the recommendations in this current guideline were conducted by sleep physicians and investigators as defined by the above criteria.

Results

Our assessment of the efficacy of different OAs, as compared to each other and to PAP for different levels of OSA severity (mild, moderate, and severe), was based on very limited evidence. Most of the studies accepted for inclusion in this guideline did not provide sub-analyses of results based on different levels of OSA severity. Therefore, the recommendations presented below do not provide guidance for treating OSA patients with specific levels of severity. Meta-analyses performed using the limited available evidence indicates that OAs can significantly reduce the apnea hypopnea index/respiratory disturbance index/respiratory event index (AHI/RDI/REI) across all levels of OSA severity in adult patients. There was no statistically significant difference in the mean reduction in AHI before and after treatment using OAs versus CPAP across all levels of OSA severity. Moreover, there was no significant difference between OAs and CPAP in the percentage of mild OSA patients achieving their target AHI/RDI/REI (< 5, < 10, > 50% reduction) after treatment. For patients with moderate to severe OSA, however,

the odds of achieving the target AHI were significantly greater with CPAP than with OAs.

Our assessment of factors that may be used to predict treatment success in adults with OSA was also based on very limited evidence. We found that treatment success was usually defined as a reduction in the AHI/RDI/REI to a specific level (e.g., post-treatment AHI/RDI/REI < 5, > 50% reduction in AHI/RDI/REI). However, there were no reported factors that consistently predicted treatment success. Specifically, there was conflicting evidence for the use of age, gender, neck circumference, body mass index (BMI), and cephalometric measurements to predict treatment success. Patient preference for OA versus CPAP should be considered by the treating sleep physician before therapy is prescribed. The strength of each recommendation was not only made based on the quality of evidence, but also incorporated patient preference along with other factors such as cost, value, and other patient-related factors.

Summary of Recommendations

1. We recommend that sleep physicians prescribe oral appliances, rather than no therapy, for adult patients who request treatment of primary snoring (without obstructive sleep apnea). (STANDARD)

Quality of Evidence: High

Values and Trade-Offs: Oral appliances (OAs) reduce the frequency and intensity of snoring, improve sleep quality for both patients who snore and their bed partners, and improve quality of life (QOL) measures. Though the available evidence on these outcomes is limited, we gave this a STANDARD strength of recommendation, as the possible benefits from treatment of primary snoring clearly outweigh the risk. Insufficient evidence exists to conclude that treatment of primary snoring improves other health-related outcomes, or to compare objective sleep quality during use of oral appliances versus other treatments. Therefore, OAs should be recommended for patients who snore who fail conservative measures (such as weight loss, positional therapy, and avoiding alcohol) and request further treatment. Diagnosis of primary snoring should be rendered by a sleep physician and not a dentist, as snoring is frequently accompanied by OSA, and misdiagnosis can have serious implications for the patient.

2. When oral appliance therapy is prescribed by a sleep physician for an adult patient with obstructive sleep apnea, we suggest that a qualified dentist use a custom, titratable appliance over non-custom oral devices. (GUIDELINE)

Quality of Evidence: Low

Values and Trade-Offs: The overall grade for the body of evidence exploring the impact of custom vs. non-custom OAs to treat OSA varies between low and moderate depending on the physiologic sleep outcome measures. A systematic review of the evidence has shown that custom, titratable OAs reduce the AHI, arousal index, and oxygen desaturation index, and increase oxygen saturation to a greater extent than do non-custom OAs. The evidence supports the use of custom, titratable OAs over other types of appliances. Although the reduction in AHI and ODI are similar for both custom, titratable and custom, non-titratable OAs, the confidence interval for the effect of the custom, titratable OAs is considerably smaller than for the custom, non-titratable appliances. Both types of custom appliances are more effective than non-custom OAs.

Neither custom nor non-custom OAs have been shown to significantly affect sleep architecture and sleep efficiency. However, the overall improvement in other physiologic sleep parameters with the use of custom OAs in adult patients with OSA should result in an improvement in daily function and quality of life.

The available data also suggest that OAs effectively improve daytime sleepiness. The mean change in the Epworth Sleepiness Scale (ESS) with custom, titratable OAs is moderate. The reduction in subjective daytime sleepiness achieved with custom titratable OAs is not inferior to that reported with CPAP therapy. In contrast, very limited data suggest that custom, non-titratable OAs do not produce a significant change in ESS. Insufficient data are available to assess objective measures of sleepiness or wakefulness following OA therapy.

The evidence indicates that OAs are also effective in improving QOL. Specifically, custom, titratable OAs provide moderate improvement in QOL outcomes. The data on QOL is very limited for custom, non-titratable OAs, and therefore their use cannot be recommended to improve QOL.

3. We recommend that sleep physicians consider prescription of oral appliances, rather than no treatment, for adult patients with obstructive sleep apnea who are intolerant of CPAP therapy or prefer alternate therapy. (STANDARD)

Quality of Evidence: Moderate

Values and Trade-Offs: A review of the evidence suggests that adherence rates using OAs are greater than those observed with CPAP. However, no randomized controlled trials have assessed objective OA adherence rate as compared with CPAP. The subjective reporting of adherence rate is prone to bias, and needs to be interpreted with caution as patients may overestimate their OA use. However, a patient whose OSA does not improve with the use of CPAP or is intolerant to CPAP may benefit from the use of an OA. Overall, the discontinuation of therapy due to side effects occurs less when using OAs versus CPAP to treat adult patients with OSA.

The overall grade for the body of evidence on the impact of OAs to treat obstructive sleep apnea (OSA) varies between low and moderate depending on the physiologic sleep outcome measures. A systematic review of the evidence has shown that OAs reduce AHI, arousal index, and oxygen desaturation index, and increase oxygen saturation. However, OAs have shown no significant effect on sleep architecture and sleep efficiency. The overall improvement in physiologic sleep parameters with the use of OAs in adult patients with OSA should result in an improvement in daily function and quality of life. Although OAs have been shown to improve physiologic sleep parameters, continuous positive airway pressure (CPAP), in our meta-analyses, was found to be superior to OAs

in reducing the AHI, arousal index, and oxygen desaturation index and improving oxygen saturation, and therefore, should still generally be the first-line option for treating OSA. The improvement in QOL produced by custom, titratable OAs is not inferior to that reported with CPAP therapy. The quality of evidence for the use of these OAs to improve QOL is moderate, whereas the quality of evidence comparing OAs to CPAP is low. The custom, titratable OAs improve QOL, but as with CPAP, reduced QOL may persist despite otherwise adequate therapy.

The available data regarding the impact of OAs on blood pressure are more limited (overall grade for the body of evidence is low) than the data addressing blood pressure change with CPAP. For example, the role of OAs in patients with resistant hypertension has not yet been evaluated. However, the available data suggest that OAs may be as effective as CPAP in at least select patient populations to lower blood pressure and therefore should not preclude the use of either therapy or diminish the other established benefits that accrue from treatment of OSA. Of note, no RCTs have assessed the impact of OA therapy on other cardiovascular endpoints.

In summary, OAs may be effective in improving sleep parameters and outcomes of OSA, and there is little likelihood of harm. Although they are not as efficacious as PAP therapy, the benefits of using OAs outweigh risks of not using OAs. Thus, a STANDARD strength of recommendation to use OAs was provided.

4. We suggest that qualified dentists provide oversight—rather than no follow-up—of oral appliance therapy in adult patients with obstructive sleep apnea, to survey for dental-related side effects or occlusal changes and reduce their incidence. (GUIDELINE)

Quality of Evidence: Low

Values and Trade-Offs: Beneficial treatment effects may be reduced by treatment-related side effects, and most OA therapy side effects are dental. A wide range of devices made from a variety of materials and having different characteristics are utilized in clinical practice. Literature on dentists performing interventions to prevent failure of OA therapy is limited, although the topic is mentioned in the results and discussion sections of some publications. Therefore, the overall evidence in support of the above recommendation was considered low. Nevertheless, minimization of side effects may improve adherence and thereby patient outcomes. Several studies demonstrated dental interventions to mitigate side effects. Additionally, knowledge of dental materials and a variety of dental devices including the knowledge of the patients' dental status will likely ensure fewer side effects. A qualified dentist will be able to screen for many problems and choose and/or build the OA with features to minimize the side effects of the therapy. A qualified dentist will have the skills to choose the proper OA and make necessary modifications to accommodate patients who, among other things, may have allergies to metals or acrylics, are strong teeth grinders, or have anatomical deviations. The patient's history and exam, appliance preference, and review of any side effects should be taken into account to avoid device breakage, allergic reactions, or discomfort that leads to frustration or discontinuation of the therapy.

5. We suggest that sleep physicians conduct follow-up sleep testing to improve or confirm treatment efficacy, rather than conduct follow-up without sleep testing, for patients fitted with oral appliances. (GUIDELINE)

Quality of Evidence: Low

Values and Trade-Offs: The overall grade of evidence for support of follow-up evaluations and testing by sleep physicians is low due to a lack of evidence. However, the discussion sections in most research studies report significant improvement in OA efficacy when changes were made to the appliances based on data obtained either during or after the sleep studies. While insufficient evidence exists to produce a meta-analysis, the available data suggest that subjective feedback is not sufficient to determine the optimal setting of the OA in the management of OSA. Without objective data the patient may, unnecessarily, remain sub-optimally treated. Follow-up sleep testing by sleep physicians should also be considered for OA-treated patients who develop recurrent symptoms, show substantial weight changes, or receive diagnoses of comorbidities relevant to OSA.

6. We suggest that sleep physicians and qualified dentists instruct adult patients treated with oral appliances for obstructive sleep apnea to return for periodic office visits—as opposed to no follow-up—with a qualified dentist and a sleep physician. (GUIDELINE)

Quality of Evidence: Low

Values and Trade-Offs: A review of the evidence suggests that patients may benefit from periodic follow-up visits with a physician and with a qualified dentist. Several studies have demonstrated that adjustments made to the OA by a dentist, based on data obtained from PSGs and home sleep apnea tests conducted by a physician, may result in greater long-term improvement in OSA. The absence of periodic follow-up visits may result in suboptimal improvement in OSA or side effects that increase risk for discontinuation of therapy.

1.0 INTRODUCTION

Snoring and obstructive sleep apnea (OSA) are common sleep disorders resulting from repetitive narrowing and collapsing of the upper airway. Untreated OSA is associated with multiple adverse health outcomes including systemic hypertension, coronary artery disease, stroke, atrial fibrillation, increased motor vehicle accidents, congestive heart failure, daytime sleepiness, decreased quality of life, and increased mortality.[1] Snoring is also a significant social problem and contributes to decreased quality of life for bed partners through disrupted sleep.[2] Snoring itself may have a negative health impact, such as increased risk for cardiovascular disease.[3]

In recent years, oral appliances (OAs) have become an increasingly common treatment modality for OSA and snoring. Although positive airway pressure (PAP) remains the most common and most efficacious treatment for sleep disordered breathing, OAs offer effective therapy for many patients with OSA. These devices offer advantages over PAP in that they do not require a source of electricity and are less cumbersome, especially with travel. Oral appliances are well tolerated in most patients, and therapeutic adherence may be better than CPAP.[4]

Since the publication of the initial position statement by the American Academy of Sleep Medicine (AASM) in 1995, the clinical use of OAs for the treatment of snoring and obstructive sleep apnea has markedly increased. The most recent AASM practice parameters on the treatment of snoring and OSA with oral appliances was published in 2006 as "Practice Parameters for the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances: An Update for 2005" with the accompanying systematic review paper "Oral Appliances for Snoring and Obstructive Sleep Apnea: A Review."[5,6] Since the publication of the previous review paper and practice parameters, the scientific literature on oral appliances has grown considerably, particularly related to clinical outcomes after use of OAs, and hence the recommendations in this guideline will replace the recommendations in the 2006 guideline for the use of OAs in the treatment of OSA and snoring.

This guideline refers to a "qualified dentist" as the dental provider of choice to provide oral appliance therapy. The successful delivery of oral appliances requires technical skill, acquired knowledge, and judgment regarding outcomes and risks of these therapies. The need to append the word "qualified" stems from two things: (1) all of the studies conducted to evaluate the efficacy and risks of oral appliances were conducted by dentists with considerable experience in dental sleep medicine, and (2) the unfortunate fact that training in dental sleep medicine is uncommon. Therefore, not all dentists have the training or experience required to deliver knowledgeable care, and application of the literature to practice dental sleep medicine.

The American Academy of Dental Sleep Medicine (AADSM) is one of several organizations that has begun to address this issue over the past decade via the development and delivery of educational programs in dental sleep medicine along with the development of a certifying examination in dental sleep medicine that is now administered and maintained by the American Board of Dental Sleep Medicine (ABDSM). As physicians diagnose and subsequently refer patients with OSA to select dentists to evaluate for delivery of oral appliance therapy, they should seek qualified dentists who have a valid state license and proof of liability coverage and possess additional training or experience in this area of care. Although not all-inclusive, desirable qualifications include that the dentist have at least one of the following: certification in dental sleep medicine by a non-profit organization, designation as the dental director of a dental sleep medicine facility accredited by a non-profit organization, or a minimum of 25 hours of recognized continuing education in dental sleep medicine (e.g., American Dental Association Continuing Education Recognition Program [ADA CERP] or Academy of General Dentistry Program Approval for Continuing Education [AGD PACE]) provided by a dental sleep medicine focused non-profit organization or accredited dental school in the last two years.

OSA is a chronic disorder and, therefore, would be best diagnosed and followed by a sleep physician in cooperation with any other healthcare providers the patient may be going to for treatment (their primary care physician, a qualified dentist, ENT, etc.). For the purposes of this guideline, a sleep physician is defined as a physician who is either sleep board-certified or sleep board-eligible. A multicenter, prospective, comparative effectiveness study showed that board-certified sleep physicians and accredited centers improved patient-centered outcomes for OSA patients.[7] Also, most of the RCTs that were reviewed to develop the recommendations in this current guideline were conducted by sleep physicians and investigators as defined by the above criteria.

2.0 BACKGROUND

2.1 Nomenclature, Types, and Definition of an Effective Oral Appliance

Oral appliances are devices intended to protrude and stabilize the mandible to maintain a patent airway during sleep.[8] A custom OA is "fabricated using digital or physical impressions and models of an individual patient's oral structures. As such, it is not a primarily prefabricated item that is trimmed, bent, relined, or otherwise modified. It is made of biocompatible materials and engages both the maxillary and mandibular arches."[8] Non-custom OAs, commonly known as "boil and bite devices," are primarily prefabricated and usually partially modified to an individual patient's oral structures. There are also custom-made and non-custom-made OAs that hold the tongue forward and are called tongue retaining devices (TRDs), and these have to be distinguished from the OAs. There was insufficient evidence to assess the efficacy of TRDs for the treatment of adult patients with OSA.

In addition to being custom- or non-custom-made, OAs are either titratable or non-titratable. Titratable OAs have a mechanism that allows for varying amounts of mandibular protrusion. The increasing protrusion of the mandible is considered analogous to the titration of continuous positive airway pressure (CPAP). Non-titratable OAs hold the mandible in a single protrusive position, and no changes are possible over the course of treatment.

The American Academy of Dental Sleep Medicine (AADSM) published a definition of an *effective* OA in March 2013,

Table 1—PICO Questions.

1. In adult patients with primary snoring, do oral appliances (OAs) improve snoring, sleep quality, including the bed partner's sleep quality, and/or quality of life measures compared to other therapies or no treatment?
2. In adult patients with obstructive sleep apnea (OSA) (irrespective of underlying severity of OSA, and for each mild, moderate, or severe OSA), do oral appliances improve the apnea hypopnea index (AHI)/respiratory disturbance index (RDI)/respiratory event index (REI), oxygen saturation, arousal index, and/or sleep architecture compared to other therapies or no treatment?
3. In adult patients with OSA, do OAs improve cardiovascular endpoints, such as hypertension, coronary artery disease, myocardial infarction, and/or arrhythmias, as compared to other therapies or no treatment?
4. In adult patients with OSA, do OAs improve quality of life measures, and/or objective and subjective daytime sleepiness, as compared to other therapies or no treatment?
5. In adult patients with OSA, do titratable OAs improve AHI/RDI/REI, oxygen saturation, arousal index, and/or sleep architecture and do they improve long-term management of OSA with outcome measures such as AHI/RDI/REI, sleep quality, quality of life measures, cardiovascular endpoints, and/or subjective/objective measures of sleepiness compared to non-titratable OAs?)
6. In adult patients with OSA, do OAs lead to mild or serious side effects compared to those treated with other therapies or no treatment?
7. In adult patients with OSA, do follow-up oximetries, home sleep apnea tests, polysomnograms, or follow-up with a sleep physician improve long-term management with OAs as compared to no follow-up?
8. In adult patients with OSA, does follow-up with dentists/sleep specialists improve adherence and reduce side effects associated with OAs compared to those who do not have follow-up?
9. In adult patients with OSA, does OA use show better adherence than that reported by subjective or objective measures for PAP therapy?
10. In adult patients with OSA, do different types of OAs have variable effectiveness in controlling sleep-disordered breathing as measured by the AHI/RDI/REI and/or other outcome measures such as sleep quality, quality of life measures, cardiovascular endpoints, and/or objective/subjective daytime sleepiness?
11. In adult patients with OSA, what are the factors that predict success with OAs compared to other therapies or no treatment?

focusing on custom-titratable OAs.[8] This definition was developed at a consensus conference attended by a group of experienced dental sleep medicine researchers and clinicians using a modified RAND Appropriateness Method. The definition was unanimously approved by the conference attendees and then subsequently approved by the AADSM Board of Directors. A manuscript detailing the conference, the process, the literature search, grading, and review has also been published.[8]

Currently, there is no universal terminology to describe oral appliances that are used to treat OSA. The plethora of terms is potentially confusing. Commonly used terms include, but are not limited to: mandibular advancement device (MAD), mandibular repositioning device (MRD), mandibular advancement splint (MAS), and mandibular advancement appliance (MAA). Throughout this guideline paper, we use the term "oral appliance (OA)" to refer to all of these different types. We will, however, specify whether they are custom or non-custom made and whether they are titratable or non-titratable OAs. A preferred term chosen by the AADSM may lead to less confusion in the field.

3.0 METHODS

3.1 Expert Task Force

To develop this guideline, the AASM and AADSM commissioned a Task Force of seven members, three sleep medicine physicians and two dentists with expertise in the use of oral appliances, and two AASM research staff members experienced in guideline development. Prior to being appointed to the Task Force, the content experts were required to disclose all potential conflicts of interest (COI) according to the AASM's COI policy. None of the task force members had any conflicts that would preclude participation in this effort. The Task Force members performed an extensive review of the scientific literature to draft recommendations and supporting text for the use of OAs in the treatment of snoring and OSA.

3.2 PICO Questions

PICO (patient, population or problem, intervention, comparison, and outcomes) questions were developed based on both the questions raised in the 2006 AASM review paper[5] and practice parameter[6] and review of systematic reviews, meta-analyses, and guidelines published since then (Table 1). The PICO format is an established framework for subsequently guiding literature searches targeted at addressing the PICO questions and developing evidence-based clinical practice recommendations. After a thorough review, editing, and approval of these questions by the task force members, the AASM Board of Directors approved the final list of PICO questions before the targeted literature search was performed.

3.3 Literature Search

The Task Force members performed an extensive review of the scientific literature to retrieve articles which addressed at least one of the eleven PICO questions. The literature search was performed by the AASM research staff using the PubMed and Embase databases. Though the search yielded all types of articles with various study designs, for most PICO questions the analysis was limited to only randomized controlled trials (RCTs) as RCTs are considered a higher quality of evidence than observational, nonrandomized, or before-after interventional studies. The RCTs that were cited in the 2006 AASM review paper[5] and 2006 practice parameter paper[6] were included for data analysis if they met the study inclusion criteria. For PICO questions 7 and 11, due to lack of RCTs, we relied on prospective observational studies. The literature search in PubMed was conducted using a combination of MeSH terms and keywords. The MeSH terms were: Sleep Apnea Syndromes, Snoring, Orthodontic Appliances, and Mandibular Advancement/Instrumentation.

The keywords were: sleep apnea, sleep apnoea, sleep-related breathing disorders, sleep-disordered breathing, oral, intraoral, dental, orthodontic, mandibular, tongue-retaining, tongue-stabilizing, occlusal, titratable, titrated, appliance(s), splint(s), device(s), OA, or snoring. The limits of the search (criteria that all had to be met) were: humans, English, all adults (no pediatrics), and RCTs. The RCT limitation was not used for PICO questions 7 and 11. The PubMed database was searched from January 1, 2004, through July 31, 2012, for any relevant literature published since the last guideline. This search was updated again on February 28, 2013, to capture the latest literature. A total of 324 citations were identified in PubMed and supplemented by pearling (i.e., checking the reference sections of search results for articles otherwise missed). The literature search in Embase was performed using a combination of disorder and treatment terms. The disorder terms were: sleep apnea, sleep apnoea, sleep apnea syndrome, sleep-related breathing disorders, or sleep-disordered breathing. The treatment terms were: orthodontic device, mandible reconstruction, oral, intraoral, dental, orthodontic(s), mandibular, tongue retaining, tongue-stabilizing, occlusal, titratable, or titrated. The presence of any one of these terms in the title or abstract of a publication would identify a potentially relevant article for inclusion in data analysis. The limits of the search were: humans, English, adults, and RCTs. The RCT limitation was not used for PICO questions 7 and 11. The Embase database was searched from January 1, 2004, through August 31, 2012. This search was updated again on February 28, 2013, to capture the latest literature and cross-checked with the results from the PubMed search to find any previously unidentified articles. A total of 53 citations were identified in Embase, yielding a total of 377 citations from both databases.

Abstracts from these articles were assessed by two task force members to determine whether they met inclusion criteria. However, if there were any questions on whether the abstract met the inclusion criteria, the article was reviewed in detail to determine whether to accept or reject. Articles were included for evaluation if they focused on treatment of snoring and/or OSA with OAs, and included only adult subjects. Included articles also had to address at least one of the eleven "PICO" questions identified ahead of the review process. Articles were accepted if they used either the apnea hypopnea index (AHI) or the respiratory disturbance index (RDI) as determined by an overnight polysomnogram (PSG) or the respiratory event index (REI) as determined by a home sleep apnea test. However, there were 3 articles that did not necessarily meet the above criteria, but were still included in our analysis.[9–11] In two studies by Gauthier et al., RDI was defined as the combination of apneas, hypopneas and arousals per hour of sleep,[9,10] while Gotsopoulos et al. defined AHI as the combination of apneas, hypopneas, and arousals per hour of sleep.[11] The Task Force acknowledges that there are limitations to the direct comparisons made in this guideline due to the variety of ways AHI, RDI, and REI are defined and scored among the studies included. Articles were excluded if they focused on diagnosis, described the use of OAs to treat central or complex sleep apnea, or if they were studies on pediatric patients. A total of 51 articles met these criteria and were used for data extraction, meta-analysis, and grading.

3.4 Meta-Analysis

Meta-analysis was performed with Review Manager 5.2 software to compare various types of OAs used to treat snoring and OSA. Oral appliances were categorized into the following types: custom, titratable; custom, non-titratable; non-custom, titratable; and non-custom, non-titratable. Meta-analysis was performed for each PICO question by pooling data across studies for each outcome measure. All analyses were performed using the random effects model. The result of each meta-analysis is shown in a forest plot. Individual studies in the meta-analysis are identified in a table that includes the mean and standard deviation (SD) of the outcome measure and the number of patients. The pooled results are expressed as the total number of patients and mean difference between the experimental treatment and the control or between the baseline and final values of the outcome measure. The center of the black diamond at the bottom of the plot indicates the mean difference (i.e., average response or magnitude of effect) across all studies. The width of the black diamond represents the 95% confidence interval of the mean difference. The zero line represents no effect. If the black diamond does not touch the zero line, and lies beyond the clinical decision threshold, the treatment is considered either effective or ineffective depending on which side of the zero line the diamond lies.

It should be noted that for a number of PICO questions there was insufficient evidence to perform meta-analyses for certain comparisons and outcome measures. For example, the efficacy of OAs was only compared with CPAP, as there was insufficient evidence to compare OAs to other therapies, such as conservative treatment or surgery. Therefore, the content of this guideline includes comparisons, outcome measures, and recommendations for which there was sufficient evidence. It should also be noted that meta-analysis of head-to-head studies was only performed when comparing the efficacy of OAs to CPAP. Due to insufficient head-to-head studies comparing different types of OAs (e.g., custom, titratable vs. custom, non-titratable), data on the efficacy of specific device types were pooled across studies and compared side by side. The meta-analyses are presented in the Appendix.

3.5 Quality of Evidence

The assessment of evidence quality was performed according to a modified Grading of Recommendations Assessment, Development, and Evaluation (GRADE) process.[12] The GRADE system differs from other grading systems in that each study is not only evaluated for study design and risk of bias, but, additionally, an estimate of effect is generated for each outcome. The quality of evidence reflects the degree of confidence that the estimates of the effects are correct, and the quality of a body of evidence for each outcome is assessed as opposed to evaluating individual studies. Multiple aspects of quality are assessed including study limitations, imprecision, inconsistency of results, indirectness of evidence, and likeliness of publication bias.

A risk of bias analysis was performed on all RCTs. Analyzing risk of bias includes reviewing aspects of conduct such as blinding, allocation concealment, loss to follow-up, or selective outcome reporting that could affect the quality of evidence. The GRADE process allows for the downgrading of the quality

Table 2—A summary of GRADE's approach to rating quality of evidence.

Study Design	Initial Quality of a Body of Evidence	Downgrade if	Upgrade if	Quality of a Body of Evidence
Randomized trials	High →	Risk of bias −1 Serious −2 Very serious Inconsistency −1 Serious −2 Very serious Indirectness −1 Serious −2 Very serious Imprecision −1 Serious −2 Very serious Publication bias −1 Serious −2 Very serious	Large effect +1 Large +2 Very large Dose response +1 Evidence of a gradient All plausible residual confounding +1 Would reduce a demonstrated effect +1 Would suggest a spurious effect if no effect was observed	High (four plus: ⊕⊕⊕⊕) Moderate (three plus: ⊕⊕⊕⊖) Low (two plus: ⊕⊕⊖⊖) Very Low (one plus: ⊕⊖⊖⊖)
Observational studies	Low →			

Table 3—Final assessments of level of bodies of evidence.

High:	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate:	We are moderately confident in the effect estimate. The true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different.
Low:	Our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of effect.
Very low:	We have very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of effect.

Table 4—AASM strengths of recommendations.

	Overall Quality of Evidence			
Assessment of Benefits versus Harms/Burdens	**High**	**Moderate**	**Low**	**Very Low**
Benefits clearly outweigh harms/burdens	STANDARD	STANDARD	GUIDELINE	OPTION
Benefits closely balanced with harms/burdens OR Uncertainty in the estimates of benefits versus harms/burdens	GUIDELINE	GUIDELINE	OPTION	OPTION
Harms/burdens clearly outweigh benefits	STANDARD	STANDARD	STANDARD	STANDARD

of evidence due to risk of bias. The grading of evidence also includes an analysis of imprecision, indirectness, and inconsistency. Imprecision refers to wide confidence intervals around the estimate of effect when there are relatively few patients and few events. Indirectness occurs when the question being addressed is different than the available evidence in terms of population, intervention, comparator, or outcome. There is inconsistency when there is unexplained heterogeneity of the results. A summary of the GRADE approach to rating quality of evidence is presented in Table 2.

All studies were assessed for study design and limitations to validity (bias) for each outcome of interest. Subsequently, the body of evidence for each outcome was assessed and graded, taking into account the results of the meta-analysis (if applicable) and other factors as described above. The final assessment, as defined in Table 3, was determined for each treatment and outcome measure. The results are reported as evidence profiles, for each PICO question, that include the number of studies, study design, limitations, inconsistency, indirectness, imprecision, and other considerations that went into determining the quality of evidence for each outcome of interest. Also reported are the number of patients that were studied, the overall effect that was calculated in the meta-analysis (reported as the *mean difference* [MD]), and a qualitative assessment of the relative importance of the outcome. Task force members and AASM staff extracted the data and graded the studies. The GRADE summary of findings reports, along with the meta-analyses, are presented in the Appendix.

3.6 Strength of Recommendations

The task force then developed recommendations for the efficacy of OA treatment for snoring and OSA. Strengths of recommendation were assigned to these statements based on the strength of evidence and counterbalanced by an assessment of the relative benefits of the treatment versus the potential risks as delineated in Table 4. Particularly noteworthy on this table is that when the harm or burden clearly outweighs the benefit, a STANDARD strength of recommendation *against* the proposed therapy is given regardless of the overall quality of evidence.

Sections titled "Values and Trade-offs" appear under each individual recommendation to explain the rationale leading to each recommendation. These sections are an integral part of the GRADE system and offer transparency to the process.

Table 5—Summary of recommendation statements.

Recommendation Statement	Strength of Recommendation	Quality of Evidence	Benefits versus Harms/Burdens Assessment
The Use of Oral Appliances for Treatment of Primary Snoring in Adults			
We recommend that sleep physicians prescribe oral appliances, rather than no therapy, for adult patients who request treatment of primary snoring (without obstructive sleep apnea).	STANDARD	High	Benefits clearly outweigh harms
The Use of Oral Appliances for Treatment of Obstructive Sleep Apnea in Adults			
When oral appliance therapy is prescribed by a sleep physician for an adult patient with obstructive sleep apnea, we suggest that a qualified dentist use a custom, titratable appliance over non-custom oral devices.	GUIDELINE	Low	Benefits clearly outweigh harms
We recommend that sleep physicians consider prescription of oral appliances, rather than no treatment, for adult patients with obstructive sleep apnea who are intolerant of CPAP therapy or prefer alternate therapy.	STANDARD	Moderate	Benefits clearly outweigh harms
We suggest that qualified dentists provide oversight—rather than no follow-up—of oral appliance therapy in adult patients with obstructive sleep apnea, to survey for dental-related side effects or occlusal changes and reduce their incidence.	GUIDELINE	Low	Benefits clearly outweigh harms
We suggest that sleep physicians conduct follow-up sleep testing to improve or confirm treatment efficacy, rather than conduct follow-up without sleep testing, for patients fitted with oral appliances.	GUIDELINE	Low	Benefits clearly outweigh harms
We suggest that sleep physicians and qualified dentists instruct adult patients treated with oral appliances for obstructive sleep apnea to return for periodic office visits—as opposed to no follow-up—with a qualified dentist and a sleep physician.	GUIDELINE	Low	Benefits clearly outweigh harms

3.7 Approval and Interpretation of Recommendations

A draft of the guideline was available for public comment for a two-week period on the AASM and AADSM websites. The task force took into consideration all the comments received and made decisions about whether to revise the draft based on the comments. The revised guideline was submitted to the AASM and AADSM Board of Directors who subsequently approved these recommendations.

The recommendations in this guideline define principles of practice that should meet the needs of most patients in most situations. This guideline should not, however, be considered inclusive of all proper methods of care or exclusive of other methods of care reasonably expected to obtain the same results. The ultimate judgment regarding propriety of any specific care must be made by the clinician (sleep physician and dentist), in light of the individual circumstances presented by the patient, available diagnostic tools, accessible treatment options, and resources.

The AASM expects this guideline to have an impact on professional behavior, patient outcomes, and, possibly, health care costs. This clinical practice guideline reflects the state of knowledge at the time of publication and will be reviewed every few years and updated if new evidence warrants significant changes to the recommendations.

4.0 RECOMMENDATIONS

All figures, including meta-analyses and GRADE profile reports, are presented in the Appendix. Table 5 shows a summary of the recommendation statements organized by strength of recommendation, including the quality of evidence and the assessment of the harm/benefit balance of the recommendation.

Our assessment of the efficacy of different OAs, as compared to each other and to PAP for different levels of OSA severity (i.e., mild, moderate, and severe), was based on very limited evidence. Most of the studies accepted for inclusion in this guideline did not provide sub-analyses of results based on different levels of OSA severity. Therefore, the recommendations presented below do not provide guidance for treating OSA patients with specific levels of severity. Meta-analyses performed using the limited available evidence indicate that both OAs and CPAP can significantly reduce the apnea hypopnea index/respiratory disturbance index/respiratory event index (AHI/RDI/REI) across all levels of OSA severity in adult patients (see Figures 1–6). There were statistically significant differences in the mean reduction in AHI before and after treatment using OAs versus CPAP for mild-to-moderate and severe levels of OSA severity. Based on a single retrospective study by Holley in 2011, however, there was no significant difference in the percentage of mild OSA patients achieving their target AHI/RDI/REI (< 5, < 10, > 50% reduction) after treatment between OAs and CPAP.[13] For patients with moderate to severe OSA, however, the odds of achieving the target AHI was significantly greater with CPAP than with OAs.[13] In an RCT conducted by Randerath in 2002, the odds of achieving the target AHI of < 10 in mild to moderate adult patients was significantly greater with CPAP than OA therapy.[14] CPAP remains the first-line or primary therapy for the treatment of adult patients with severe OSA. OA therapy should be reserved for use in severe OSA patients who did not benefit from CPAP therapy or were intolerant to CPAP.[15,16]

Our assessment of factors that may be used to predict treatment success in adults with OSA was also based on very limited evidence. We found that treatment success was usually defined as a reduction in the AHI/RDI/REI to a specific level (e.g., post-treatment AHI/RDI/REI < 5, > 50% reduction in AHI/RDI/

REI). However, there were no reported factors that consistently predicted treatment success. Specifically, there was conflicting evidence for the use of age, gender, neck circumference, body mass index (BMI), and cephalometric measurements to predict treatment success.

It should be noted that conclusions drawn from side-by-side comparisons of the meta-analyses should be interpreted with caution in instances where a meta-analysis based on a limited number of RCTs for one appliance type was compared against a meta-analysis of several RCTs for another appliance type.

There was insufficient evidence to compare the efficacy of OAs to other therapies besides CPAP. Patient preference for OAs versus CPAP should be considered by the treating sleep physician before therapy is prescribed. The strength of each recommendation was not only made based on the quality of evidence, but also incorporated patient preference along with other factors such as cost, value, and other patient-related factors.

4.1 Primary Snoring

4.1.1 Snoring Indices

Oral appliances are effective for the treatment of primary snoring in adult patients without obstructive sleep apnea (Quality of evidence: *High*) The efficacy of OAs for the treatment of primary snoring in adult patients with OSA was previously addressed in the AASM Practice Parameters for the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances: An Update for 2005.[6] The existing evidence at that time supported a STANDARD strength of recommendation for use of OAs in the treatment of primary snoring without features of OSA or upper airway resistance syndrome. The prior evidence found these devices reduced subjective snoring. Since that time, additional trials have further supported this recommendation and have explored additional benefits of oral appliance therapy among these patients.

Two RCTs that assessed the effect of OAs in patients with primary snoring were identified.[17,18] An RCT conducted by Johnston et al. determined that snoring occurred on fewer nights per week; 1.90 (95% CI: 1.32, 2.48).[17] Cooke et al. observed fewer snores per hour; 278 (95% CI: 375.30, 180.70).[18] While the overall quality of this evidence is high, these trials utilized different snoring scales.

A meta-analysis was performed comparing snoring loudness before and after treatment with an OA. The results are shown in Figure 7. Two trials found snoring loudness was reduced while using an OA; 3.31 (95% CI: 1.84, 4.77).[17,18]

The summary of findings table for snoring indices is presented in Figure 8.

4.1.2 Quality of Life

There was insufficient evidence to determine the efficacy of OAs for the improvement in quality of life (QOL) in patients with primary snoring.

4.1.3 OAs vs. CPAP

There was insufficient evidence to compare the efficacy of OAs to CPAP for the reduction in primary snoring. In a prospective, randomized crossover trial, Robertson et al. found that changes in the Snoring Outcomes Survey were similar with the OA and nasal CPAP. The authors also observed that the OA was superior to CPAP in improving sleep quality among bed partners. More patients in this trial also preferred the OA over CPAP for long-term treatment of snoring.[19]

4.1 Recommendation: We recommend that sleep physicians prescribe oral appliances, rather than no therapy, for adult patients who request treatment of primary snoring (without obstructive sleep apnea). (STANDARD)

Values and Trade-Offs: Oral appliances reduce the frequency and intensity of snoring, improve sleep quality for both patients who snore and their bed partners, and improve quality of life (QOL) measures. Though the available evidence on these outcomes is limited, we gave this a STANDARD strength of recommendation, as the possible benefits from treatment of primary snoring clearly outweigh the risk. Insufficient evidence exists to conclude that treatment of primary snoring improves other health-related outcomes, or to compare objective sleep quality during use of oral appliances versus other treatments. Therefore, OAs should be recommended for patients who snore who fail conservative measures (such as weight loss, positional therapy, avoiding alcohol) and request further treatment. Diagnosis of primary snoring should be rendered by a sleep physician and not a dentist, as snoring is frequently accompanied by OSA, and misdiagnosis can have serious implications for the patient.

4.2 OSA

4.2.1 Physiologic Sleep Parameters

The evidence on the efficacy of all OAs for the improvement in physiologic sleep outcome measures is summarized in Figure 40.

The evidence on the efficacy of custom and non-custom OAs for the improvement in physiologic sleep outcome measures is summarized in Figures 41 and 42, respectively.

The evidence on the efficacy of custom, titratable and custom, non-titratable OAs for the improvement in physiologic sleep outcome measures is summarized in Figures 43 and 44, respectively.

The evidence on the efficacy of OAs vs. CPAP for the improvement in physiologic sleep outcome measures is summarized in Figure 45.

4.2.1.1 Apnea-Hypopnea Index/Respiratory Disturbance Index/Respiratory Event Index (AHI/RDI/REI)

4.2.1.1.1 All Appliance Types

Oral appliances reduce the AHI in adult patients with OSA. (Quality of evidence: *Moderate*) Since the previous practice parameter published in 2006, several RCTs evaluating the effect of OAs on AHI have been published including studies comparing OAs to CPAP.

Thirty-four RCTs with 1,301 patients assessed the effect of OAs on AHI and found an overall improvement in AHI.[4,9–11,14,17,20–47] A meta-analysis was performed on all included trials that compared AHI pre- and post-treatment with OAs. The results

are shown in Figure 9. In weighted analysis, the mean reduction in AHI was 13.60 events/h (95% CI: –15.25, –11.95) with an OA compared to the control group without OA.

Twenty-five of the 34 RCTs included in the meta-analysis reported greater than 50% reduction in AHI with the use of OAs in adult OSA patients.[11,20,21,23–25,27–36,38–44,46,47]

4.2.1.1.2 Custom vs. Non-Custom OAs

Custom OAs reduce AHI and RDI in adult patients with OSA. (Quality of evidence: *Moderate*) Thirty-three RCTs including 1,259 patients that assessed AHI with the use of custom OAs were identified.[4,9–11,14,17,20–28,30–47] Overall, custom OAs were found to substantially reduce the AHI. Meta-analysis (Figure 10) showed the mean reduction in AHI/RDI/REI for custom OAs to be 13.89 events/h (95% CI: 15.57, 12.20). Twenty-eight of the 33 RCTs included in the meta-analysis reported a greater than 50% reduction in AHI with the use of custom OAs in adult OSA patients.[9–11,20,21,23–25,27,28,30–47] Five RCTs reported a mean decrease in AHI of up to 25 events/h with the use of custom OAs.[30,34–36,44]

Non-custom OAs reduce AHI/RDI/REI in adult patients with OSA. (Quality of evidence: *Low*) Two RCTs including 42 adult patients with OSA that assessed AHI with the use of non-custom OAs were identified.[29,45] Small improvements in AHI were reported. Meta-analysis (Figure 11) showed the mean reduction in AHI for non-custom OAs to be 6.28 events/h (95% CI: –13.13, 0.56). It should be noted that the meta-analysis reports wide confidence intervals surrounding the mean reduction in AHI for each of the 2 RCTs that studied the efficacy of non-custom OAs.

A comparison of the results of the meta-analyses cited above suggests that custom OAs achieve a greater reduction in AHI in adult patients with OSA than non-custom OAs.

4.2.1.1.3 Custom, Titratable vs. Custom, Non-Titratable OAs

Custom, titratable OAs reduce AHI/RDI/REI in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis (Figure 12) of 27 RCTs including 1,054 patients showed the mean reduction in AHI/RDI/REI for custom, titratable OAs to be 13.80 events/h (95% CI: 15.74, 11.87).[4,9–11,14,20–22,24–27,30–42,44,47] Twenty-two of the 27 RCTs included in the meta-analysis reported greater than 50% reduction in AHI with the use of custom, titratable OAs in adult OSA pati ents.[9–11,20,21,24,25,27,30–36,38–42,44,47] Five RCTs reported a mean decrease in AHI of up to 25 events/h with the use of custom titratable OAs.[30,34–36,44] In an RCT conducted by Tan et al., the first 10 subjects were treated with a custom, non-titratable OA; but 2 subjects complained of inadequate nocturnal oral respiration and were unable to tolerate the device.[43] Therefore, the patients in the study were switched to a custom, titratable device for the remainder of the study.[43] For this reason, the study was excluded from the meta-analyses of custom, titratable and custom, non-titratable OAs.

Custom, non-titratable OAs reduce AHI/RDI/REI in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis (Figure 13) of 6 RCTs including 164 adult patients with OSA showed the mean reduction in AHI for custom, non-titratable OAs to be 12.51 events/h (95% CI: 15.23, 9.80).[17,23,24,28,45,46] Four of the 6 RCTs included in the meta-analysis reported greater than 50% reduction in AHI with the use of custom, non-titratable OAs.[23,24,28,46]

A comparison of the results of the meta-analyses cited above suggests that custom, titratable and custom, non-titratable OAs achieve an equivalent reduction in AHI in adult patients with OSA.

4.2.1.1.4 OAs vs. CPAP

CPAP reduces AHI/RDI/REI more than OAs in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis performed on 15 RCTs (9 of them published since the 2006 practice parameters paper) evaluated 491 patients assigned to an OA and 481 assigned to CPAP to assess the effect of these devices on AHI.[4,14,20–22,28–30,33–36,40,43,44] The results are shown in Figure 14. In weighted analysis, OAs produced a significant mean reduction in AHI, however the mean reduction in AHI was 6.24 events/h (95% CI: 8.14, 4.34) greater with CPAP than with OA.

A study by Gagnadoux et al. evaluating the effectiveness of OA vs. CPAP over a 2-month treatment period noted a complete response (> 50% reduction in AHI to < 5 events/h) in 73.2% of patients with CPAP and 42.8% with OA.[30] The odds of achieving an AHI ≤ 5 events/h was 49 times greater, and the odds of achieving an AHI ≤ 10 events/h was 89 times greater with the OA treated group compared to the control group, based on one RCT. The odds of achieving an AHI ≤ 5 events/h after treatment was 3.6 times greater.[30] Ferguson et al. reported that achieving an AHI ≤ 10 events/h was 1.9 times greater with CPAP than with OA.[4] The treatment duration with OA and CPAP in the above studies varied between 6 weeks and 4 months.

4.2.1.2 Oxygen Saturation

4.2.1.2.1 All Appliance Types

Oral appliances modestly improve minimum oxygen saturation in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis was performed on all included trials that compared pre- and post-treatment oxygen saturation when treated with OAs vs. control group without OA. The results are shown in Figure 15. In a weighted analysis of 22 RCTs that assessed 946 adult OSA patients treated with OAs, the mean improvement in oxygen saturation was 3.09% (95% CI: 2.43, 3.76).[4,9–11,14,22,26,27,29,31–41,45,47] The greatest improvements in minimum oxygen saturation with the use of OAs were reported by Hoekema et al. in 2007 and 2008; 13.0% (95% CI: 7.02, 18.98) and 12.1% (95% CI: 6.89, 17.31), respectively.[34,35] Custom, titratable appliances were used in these studies.[34,35] Nine of the 22 RCTs included in the meta-analysis did not show a statistically significant improvement in oxygen saturation with the use of OAs.[4,14,26,27,29,37,41,45,47]

4.2.1.2.2 Custom vs. Non-Custom OAs

Custom OAs modestly improve minimum oxygen saturation in adult patients with OSA. (Quality of Evidence: *Moderate*) A meta-analysis of 21 RCTs including 908 adult patients with OSA showed the mean increase in minimum oxygen saturation for custom OAs to be 3.22% (95% CI: 2.54, 3.90).[4,9–11,14,22,26,27,31,32,34–41,45,47] The results are shown in Figure 16. Eight of the 21 RCTs included in the meta-analysis did not show a statistically significant improvement in oxygen saturation with the use of custom OAs.[4,14,26,27,37,41,45,47]

Non-custom OAs do not significantly improve minimum oxygen saturation in adult patients with OSA. (Quality of evidence: *Moderate*) Two RCTs including 42 adult patients with OSA investigated changes in minimum oxygen saturation with non-custom OAs.[29,45] Meta-analysis (Figure 17) of these 2 studies revealed a statistically insignificant mean decrease in minimum oxygen saturation of 0.29% (95% CI: −3.22, 2.64).

4.2.1.2.3 Custom, Titratable vs. Custom, Non-titratable OAs

Custom, titratable OAs modestly improve minimum oxygen saturation in adult patients with OSA. (Quality of Evidence: *Moderate*) Meta-analyses were performed on 20 RCTs including 851 adult patients with OSA that assessed the impact of custom, titratable OAs on minimum oxygen saturation during their sleep.[4,9–11,14,22,26,27,31,32,34–41,47] The results are shown in Figure 18. The weighted analysis showed a mean increase of 3.15% (95% CI: 2.46, 3.84) in minimum oxygen saturation using custom, titratable OAs.

Custom, non-titratable OAs modestly improve minimum oxygen saturation in adult patients with OSA. (Quality of evidence: *Low*) A meta-analysis (Figure 19) of 3 RCTs including 57 patients showed a mean increase in minimum oxygen saturation of 4.70% (95% CI: −3.83, 13.22) when using custom, non-titratable OAs to treat adult patients with OSA.[41,45,47] Zhou et al. reported a statistically significant improvement in minimum oxygen saturation,[47] while Vanderveken et al. and Rose et al. found no significant improvement.[41,45]

A comparison of the results of the meta-analyses cited above suggests that custom, titratable and custom, non-titratable OAs achieve an equivalent improvement in minimum oxygen saturation in adult patients with OSA.

4.2.1.2.4 OAs vs. CPAP

CPAP improves minimum oxygen saturation slightly better than OAs in adult patients with OSA. (Quality of evidence: *Moderate*) Nine RCTs (5 of them published since the 2006 practice parameters paper) evaluated a total of 346 adult patients with OSA randomized to OA and 354 to CPAP to evaluate the effect on oxygen desaturation.[4,14,22,29,33–36,40] Meta-analysis (Figure 20) revealed the improvement in oxygen saturation was better with CPAP than with an OA (mean difference 3.11% [95% CI: 1.74, 4.48] higher with CPAP than with an OA). Of the 9 RCTs included in the meta-analysis, Ferguson et al. reported the greatest improvement in minimum oxygen saturation with the use of CPAP over OAs: 11.9% (95% CI: 6.71, 17.09).[4] Conversely, RCTs conducted by Hoekema et al. reported no significant differences in minimum oxygen saturation with OAs compared to CPAP.[34–36]

4.2.1.3 Arousal Index

4.2.1.3.1 All Appliance Types

Oral appliances reduce the arousal index in adult patients with OSA. (Quality of evidence: *Moderate*) Fourteen RCTs (6 of them published since the 2006 practice parameters paper) assessed 704 adult patients with OSA randomized to OAs vs. a control group and found an overall reduction in arousal index with OAs.[11,14,20–24,27,31,32,38–40,43] A meta-analysis (Figure 21) comparing the pre- and post-treatment arousal index with OAs compared to the control group showed a mean reduction of 10.78 arousals/h (95% CI: 8.02, 13.54). All RCTs reported a statistically significant reduction in arousal index using OAs. The findings by Barnes et al. and Randerath et al., while statistically significant, were considered clinically insignificant using custom OAs.[14,22] All other RCTs reported clinically significant reductions in arousal index using custom OAs.[20,21,27,31,32,44–46,49] Aarab et al., Blanco et al., and Ghazal et al. reported > 50% reduction in arousal index using OAs.[21,23,31] Deanne et al. performed an RCT comparing an OA to a tongue retaining device and found that the OAs reduced the arousal index from 33.23 ± 16.41 arousals/h to 21.09 ± 9.27 arousals/h, p = 0.004, while the tongue retaining device decreased it to 21.09 ± 10.56 arousals/h, p = 0.001.[27]

4.2.1.3.2 Custom vs. Non-Custom OAs

Custom appliances have an impact on lowering arousal index. (Quality of Evidence: *Moderate*) Since all of the custom appliances evaluated for improvement in arousal index were custom, titratable appliances, the meta-analysis results for all OAs above also apply to custom appliances. (Figure 21)

There was insufficient evidence to assess the efficacy of non-custom OAs for improvement in arousal index in adult patients with OSA.

4.2.1.3.3 Custom, Titratable vs. Custom, Non-titratable OAs

Custom, titratable appliances have an impact on lowering arousal index. (Quality of Evidence: *Moderate*) Twelve RCTs assessed 648 adult patients with OSA randomized to OAs vs. a control group and found an overall reduction in arousal index with OAs.[11,14,20–22,24,27,31,32,38–40] A meta-analysis (Figure 22) comparing the pre- and post-treatment arousal index with OAs compared to the control group showed a mean reduction of 10.44 arousals/h (95% CI: 7.45, 13.44). An RCT conducted by Randerath et al. was the only study that reported a statistically insignificant reduction in arousal index using OAs.[14] In an RCT conducted by Tan et al., the first 10 subjects were treated with a custom, non-titratable OA; but 2 subjects complained of inadequate nocturnal oral respiration and were unable to tolerate the device.[43] Therefore, the patients in the study were switched to a custom, titratable device for the remainder of the study.[43] For this reason, the study was excluded from the meta-analyses of custom, titratable and custom, non-titratable OAs.

Custom, non-titratable appliances have an impact on lowering arousal index. (Quality of Evidence: *Low*) A meta-analysis (Figure 23) of 2 RCTs[23,24] assessed 32 adult patients with OSA found a mean reduction in arousal index of 14.59 arousals/h (95% CI: 12.48, 16.71).

A comparison of the results of the meta-analyses cited above suggests that custom, titratable and custom, non-titratable OAs achieve an equivalent reduction in arousal index in adult patients with OSA.

4.2.1.3.4 OAs vs. CPAP

CPAP reduces the arousal index more than OAs in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis (Figure 24) of 6 RCTs (3 of them published since the 2006 practice parameters paper) assessed 274 adult patients with OSA randomized to OAs vs. 272 randomized to CPAP.[14,20–22,40,43] A meta-analysis demonstrated that CPAP was moderately better than an OA in reducing the overall arousal index (mean

difference in arousal index reduction was 3.57 arousals/h (95% CI: 1.64, 5.51) better with CPAP than OA). Barnes et al. reported the most significant differences in the mean reduction in arousal index between the use of OAs and CPAP; 5.50 arousals/h (95% CI: 5.82, 5.18).[22] Aarab et al., Phillips et al., Randerath et al., and Tan et al. reported no significant difference between OAs and CPAP.[14,20,21,40,43]

4.2.1.4 Oxygen Desaturation Index (ODI)

4.2.1.4.1 All Appliance Types

Oral appliances lower the ODI in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis (Figure 25) of 6 RCTs (3 of them published since the 2006 practice parameters paper) that included 399 adult patients with OSA found a mean reduction in ODI of 12.77 events/h (95% CI: 8.69, 16.85).[17,22,31,40,46,47] Four out of the 6 RCTs included in the meta-analysis reported > 50% reduction in ODI using OAs.[31,40,46,47] In an RCT of 2 different OAs, Ghazal et al. noted an improvement in ODI from 16.0 events/h (4–22) to 8.0 events/h (1–12), $p < 0.05$ in one appliance and 14.0 events/h (2–16) to 4.0 events/h (0.8–19), $p < 0.05$ in the other.[31]

4.2.1.4.2 Custom vs. Non-Custom OAs

Custom appliances have an impact on lowering ODI. (Quality of Evidence: *Moderate*) Since all of the appliances evaluated for improvement in ODI were custom appliances, the meta-analysis results for all OAs above also apply to custom appliances (Figure 25).

There was insufficient evidence to assess the efficacy of non-custom OAs for improvement in ODI in adult patients with OSA.

4.2.1.4.3 Custom, Titratable vs. Custom, Non-Titratable OAs

Custom, titratable OAs lower the ODI in adult patients with OSA. (Quality of Evidence: *Moderate*) Meta-analysis (Figure 26) of 4 RCTs including 322 adult patients with OSA showed the mean reduction in ODI for custom, titratable OAs to be 9.95 events/h (95% CI: 16.25, 3.66).[22,31,40,47]

Custom, non-titratable OAs lower the ODI in adult patients with OSA. (Quality of evidence: *Moderate*) Three RCTs including 77 patients investigated changes in ODI with custom, non-titratable OAs.[17,46,47] Meta-analysis (Figure 27) showed the mean reduction in ODI for custom, non-titratable OAs to be 15.65 events/h (95% CI: 26.86, 4.44). Zhou et al. reported the most significant decrease in ODI with the use of a custom, non-titratable OA; 25.00 events/h (95% CI: 28.81, 21.19).[47]

A comparison of the results of the meta-analyses cited above suggests that custom non-titratable OAs achieve an equivalent reduction in ODI with custom titratable OAs in adult patients with OSA.

4.2.1.4.4 OAs vs. CPAP

CPAP reduces the ODI slightly more than OAs in adult patients with OSA. (Quality of evidence: *Low*) Three RCTs (2 of them published since the 2006 practice parameters paper) evaluated the effectiveness of OAs vs. CPAP for the treatment of adult patients with OSA.[22,30,40] Meta-analysis (Figure 28) of 234 patients randomized to an OA vs. CPAP found CPAP was slightly better at reducing the ODI compared to OAs with a mean difference in ODI of 4.76 events/h (95% CI: 2.37 to 7.15) All RCTs included in the meta-analysis reported a statistically significant difference in reduction of ODI favoring CPAP over an OA.[22,30,40]

4.2.1.5 Sleep Architecture

4.2.1.5.1 All Appliance Types

Oral appliances have no significant effect on sleep architecture in adult patients with OSA. (Quality of evidence: *Low*) A meta-analysis (Figure 29) of 17 RCTs including 636 adult patients with OSA found no clinically significant differences in REM% pre and post OA treatment (1.67, 95% CI: 0.51, 2.84).[4,9–11,14,20–24,27,29,31,32,35,38,43]

There was insufficient evidence to assess the effects of OA therapy on other measures of sleep architecture (e.g., % sleep stage time) in adult patients with OSA.

4.2.1.5.2 Custom vs. Non-Custom OAs

Custom OAs do not have a significant effect on % of REM sleep. (Quality of evidence: *Low*) A meta-analysis (Figure 30) of 16 RCTs including 620 adult patients with OSA found a clinically insignificant weighted mean increase in REM of 1.58% (95% CI: 0.64, 2.53) using custom OAs.[4,9–11,14,20–24,27,31,32,35,38,43]

Non-custom OAs do not have a significant effect on % of REM sleep. (Quality of evidence: *Moderate*) An RCT conducted by Ferguson et al. including 19 adult patients with OSA found an insignificant weighted mean increase in REM of 5.70% (95% CI: −0.56, 11.96) using a non-custom OA.[29]

4.2.1.5.3 Custom, Titratable vs. Custom, Non-Titratable OAs

Custom, titratable OAs do not have a significant effect on % of REM sleep. (Quality of evidence: Low) A meta-analysis (Figure 31) of 14 RCTs including 561 adult patients with OSA found an insignificant weighted mean increase of 1.24% (95% CI: −0.09, 2.56).[4,9–11,14,20–22,24,27,31,32,35,38]

Custom, non-titratable OAs do not have a significant effect on % of REM sleep. (Quality of evidence: Moderate) A meta-analysis (Figure 32) of 2 RCTs including 32 adult patients with OSA found an insignificant weighted mean increase of 0.97% (95% CI: 0.41, 1.53).[23,24]

4.2.1.5.4 OAs vs. CPAP

OAs and CPAP do not significantly improve % of REM sleep in adult patients with OSA. (Quality of evidence: *Low*) A meta-analysis (Figure 33) of 8 RCTs (3 of them published since the 2006 parameters paper) evaluated the effectiveness of OAs vs. CPAP in 244 adult patients with OSA randomized to CPAP and 244 randomized to an OA. The analyses found no significant differences in the % of REM sleep; 0.72 (95% CI: −1.09, 2.52).[4,14,20–22,29,30,36,43]

There was insufficient evidence to assess the effects of OAs vs. CPAP on other measures of sleep architecture (e.g., % sleep stage time) in adult patients with OSA.

4.2.1.6 Sleep Efficiency

4.2.1.6.1 All Appliance Types

Oral appliances have no significant effect on sleep efficiency in adult patients with OSA. (Quality of evidence: *Moderate*) A

meta-analysis (Figure 34) of 17 RCTs (7 of them published since the 2006 practice parameters paper) looked at 721 adult patients with OSA to evaluate sleep efficiency. There were no significant improvements in sleep efficiency; 0.95 (95% CI: −0.21, 2.12).[4,9–11,22–24,27,29,31,32,35,38,39,43,45,47] Deanne et al. performed an RCT comparing an OA vs. a tongue retaining device (TRD) and found no significant differences in sleep efficiency (baseline 80% ± 11% to 78% ± 17% with OA, p = ns vs. TRD at 79% ± 11%, p = ns).[27]

4.2.1.6.2 Custom vs. Non-Custom OAs

Custom OAs have no significant effect on sleep efficiency in adult patients with OSA. (Quality of Evidence: *Low*) A meta-analysis (Figure 35) was performed on 16 RCTs including 679 adult patients with OSA that assessed the impact of custom OAs on sleep efficiency.[4,9–11,22–24,27,31,32,35,38,39,43,45,47] The weighted analyses showed an insignificant mean improvement in sleep efficiency for custom appliances to be 0.98% (95% CI: −0.22, 2.18). RCTs conducted by Barnes et al., Ghazal et al., Gauthier et al., Gotsopoulos et al., and Zhou et al. reported statistically significant increases in sleep efficiency using custom OAs.[9–11,22,31,47]

Non-custom OAs have no significant effect on sleep efficiency in adult patients with OSA. (Quality of evidence: *Moderate*) A meta-analysis (Figure 36) was performed on 2 RCTs including 42 adult patients with OSA that assessed the impact of non-custom OAs on sleep efficiency.[29,45] The results show no significant change in sleep efficiency. The weighted analyses showed the mean decrease in sleep efficiency for non-custom OAs to be 0.30% (95% CI: −4.02, 4.62).

4.2.1.6.3 Custom, Titratable vs. Custom, Non-Titratable OAs

Custom, titratable OAs have an insignificant impact on sleep efficiency in adult patients with OSA. (Quality of Evidence: *Low*) A meta-analysis (Figure 37) was performed on 13 RCTs including 584 patients with OSA that assessed the efficacy of custom, titratable OAs for sleep efficiency.[4,9–11,22,24,27,31,32,36,38,39,47] The weighted analysis showed the mean increase in sleep efficiency to be 0.87% (95% CI: −0.43, 2.17).

Custom, non-titratable OAs have an insignificant impact on sleep efficiency in adult patients with OSA. (Quality of Evidence: *Moderate*) A meta-analysis (Figure 38) was performed on 4 RCTs including 71 patients with OSA that assessed the efficacy of custom, non-titratable OAs for sleep efficiency.[23,24,45,47] The weighted analysis showed the mean increase in sleep efficiency to be 2.71% (95% CI: −2.32, 7.73).

4.2.1.6.4 OAs vs. CPAP

OAs and CPAP do not significantly improve sleep efficiency in adult patients with OSA (Quality of evidence: *Moderate*) A meta-analysis (Figure 39) of 5 RCTs (1 of them published since the 2006 practice parameters paper), that evaluated 190 patients randomized to OAs and 191 to CPAP, found no significant difference between the 2 therapies in improving sleep efficiency; 0.37% (95% CI: −0.47, 1.21).[4,22,29,36,43]

4.2.2 Daytime sleepiness

4.2.2.1 All Appliance Types

Oral appliances reduce daytime sleepiness in adult patients with OSA. (Quality of evidence: *Moderate*) This is an expansion of the recommendations in the 2006 AASM Practice Parameters for the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances. Since publication of the 2006 practice parameters, several high quality clinical trials have established the benefits of oral appliance therapy in improving daytime sleepiness in patients with OSA.

Compared with no treatment or non-therapeutic (sham) therapy, treatment with OAs significantly improved daytime sleepiness. In meta-analysis (Figure 46) of 25 studies that measured subjective somnolence as an outcome of OA therapy, the mean reduction in the ESS was 3.81 (95% CI: 4.39, 3.23).[9–11,17,22–26,28,30,31,33–40,43–45,47,48] In a study comparing a custom OA set at 75% of the maximum mandibular advancement to a similar OA that did not advance the mandible, Blanco et al. found that daytime somnolence was improved with therapy.[23] ESS scores improved more in the advanced group, decreasing from 14.7 ± 5.1 before treatment to 5.1 ± 1.9 after 3 months of treatment (p < 0.05).[23] There was not a significant reduction in ESS among the non-advanced group (16.3 ± 2.5 to only 13.6 ± 6.7, p = NS).[23] Similarly, Gauthier et al. conducted an RCT of patients using OAs for the treatment of OSA and, after a mean follow-up period of 40.9 months, reported a decrease in ESS from 13.9 ± 1.3 to 9.3 ± 1.2 for one custom, titratable OA and from 13.9 ± 1.3 to 9.9 ± 1.3 for the other.[9] In contrast, an RCT conducted by Johnson et al. did not observe that OAs led to significant improvements in daytime sleepiness when compared to placebo.[17] The investigators utilized a fixed, non-titratable OA, which may explain the discrepancy between their observed treatment effect and other trials exploring the impact of OAs.[17] In that RCT, the ESS changed from 13.9 ± 6.4 at baseline to 11.6 ± 6.7 with an OA and 12.7 ± 6.3 with placebo (p = 0.414).[17] However, 45% of those using an OA achieved a normal ESS (< 10) following treatment.[17]

The evidence on the efficacy of OAs for the improvement of subjective daytime sleepiness is summarized in Figure 51.

4.2.2.2 Custom vs. Non-Custom OAs

Custom oral appliances reduce daytime sleepiness in adult patients with OSA. (Quality of evidence: *Moderate*) Twenty-five RCTs including 948 patients were identified that evaluated the change in ESS with the use of custom OAs.[9–11,17,22–26,28,30,31,33–40,43–45,47,48] Reductions in ESS were modest. Meta-analysis (Figure 47) showed the mean reduction in ESS score for custom OAs to be 1.95 (95% CI: 2.03, 1.88). Phillips et al., in one of the largest studies with 108 subjects, found a significant (p < 0.01) reduction in ESS from a baseline of 9.1 ± 0.4 to 7.2 ± 0.4.[40] Others such as Hoekema et al. reported larger improvements in ESS score (12.9 ± 5.6 to 4.8 ± 5.4).[35]

Non-custom oral appliances do not significantly reduce daytime sleepiness in adult patients with OSA. (Quality of evidence: *Moderate*) A single RCT including 23 patients assessed the effects of non-custom OA therapy on sleepiness in adult patients with OSA. The study reported an insignificant mean reduction in ESS of 1.0 (95% CI: −3.62, 1.62).

The evidence on the efficacy of custom and non-custom OAs for the improvement of subjective daytime sleepiness is presented in Figures 52 and 53, respectively.

4.2.2.3 Custom, Titratable vs. Custom, Non-Titratable OAs

Custom, titratable oral appliances reduce daytime sleepiness in adult patients with OSA. (Quality of evidence: *Moderate*) Nineteen RCTs including 768 patients were identified that evaluated the change in ESS with the use of custom, titratable OAs.[9–11,22,24–26,30,31,33–40,44,47] Reductions in ESS were modest. Meta-analysis (Figure 48) showed the mean reduction in ESS score for custom, titratable OAs to be 3.95 (95% CI: 4.61, 3.28).

Custom, non-titratable oral appliances reduce daytime sleepiness in adult patients with OSA. (Quality of evidence: *High*) Eight RCTs including 156 patients were identified that evaluated the change in ESS with the use of custom, non-titratable OAs.[17,23–25,28,45,47,48] Meta-analysis (Figure 49) showed the mean reduction in ESS score for custom, non-titratable OAs to be 3.65 (95% CI: 5.18, 2.13).

The evidence on the efficacy of custom, titratable and custom, non-titratable OAs for the improvement of subjective daytime sleepiness is summarized in Figures 54 and 55, respectively.

4.2.2.4 OAs vs. CPAP

OAs are equivalent to CPAP in reducing subjective daytime sleepiness in adult patients with OSA. (Quality of evidence: *Low*) Meta-analyses were performed on 10 RCTs that compared measures of daytime sleepiness between OAs and CPAP (Figure 50).[22,28,30,33–36,40,43,44] The weighted analysis of 10 trials comparing changes in the ESS between OAs and CPAP found an insignificant increase of 0.08 (95% CI: −0.21, 0.38) in post-treatment measures of subjective sleepiness between these 2 therapies.

In an RCT of patients with mild to moderate OSA, Barnes et al. compared the impact of OAs and CPAP on daytime sleepiness.[22] Both treatments led to clinically and statistically significant improvements in daytime sleepiness, with greater effects noted with CPAP therapy.[22] Compared with placebo, both treatments significantly improved subjective sleepiness as measured by the ESS ($p < 0.001$ for both OAs and CPAP).[22] There was no difference in the measured treatment effect between the 2 interventions.[22] The investigators did not observe improvements in objective sleepiness with either treatment.[22] However, the mean sleep latency on baseline maintenance of wakefulness testing (MWT) was normal among the cohort (30.7 ± 0.9 minutes), and only 18.4% had objective somnolence prior to therapy.[22] Alertness, as measured by a visual analog scale, was improved with CPAP ($p < 0.001$) but unchanged with OAs.[22] In an RCT, Hoekema et al. found that OAs performed similarly to CPAP in improving daytime sleepiness.[36] Specifically, ESS changed from 12.9 ± 5.6 at baseline to 6.9 ± 5.5 following treatment with an OA, compared with a change from 14.2 ± 5.6 to 5.9 ± 4.8 with CPAP.[36]

The evidence on the efficacy of OAs vs. CPAP for the improvement of subjective daytime sleepiness is presented in Figure 56.

4.2.3 Quality of Life

4.2.3.1 All Appliance Types

Oral appliances improve quality of life measures in adult patients with OSA. (Quality of evidence: *Moderate*) This is an expansion of the statements and associated recommendations provided in the 2006 AASM Practice Parameters for the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances. Since the publication of the 2006 practice parameters, several high quality clinical trials have established the benefits of OA therapy in improving QOL measures in patients with OSA.

Compared with no treatment or non-therapeutic (sham) therapy, treatment with OAs significantly improved QOL measures. A meta-analysis of 8 RCTs exploring the impact of OAs on QOL was performed.[22,23,26,28,31,35,37,40] The results are shown in Figure 57. Oral appliances were associated with significant improvements in QOL measures. In a weighted analysis, the mean improvement in the SF-36 scores was 6.41 (95% CI: 5.08, 7.75). In a study comparing a custom OA set at 75% of the maximum mandibular advancement to a similar OA that did not advance the mandible, Blanco et al. found that QOL was improved with therapy.[23] After 3 months of treatment, the overall FOSQ scores also improved by 27.1% from baseline in the mandibular advancement group ($p < 0.001$, effect size 0.90).[23] In comparison, the non-advanced group experienced a −1.7% decline in FOSQ.[23] Similarly, Gauthier et al. conducted an RCT of patients using OAs for the treatment of OSA.[10] After a mean follow-up period of 40.9 months, mean overall FOSQ scores improved from 13.9 ± 0.8 to 17.2 ± 0.6 ($p \leq 0.01$).[10]

The evidence on the efficacy of OAs for the improvement in QOL is summarized in Figure 61.

4.2.3.2 Custom vs. Non-Custom OAs

Custom appliances improve quality of life in patients with obstructive sleep apnea in adult patients with OSA. (Quality of Evidence: *Moderate*) The meta-analysis for all appliance types applies to custom OAs as all of the appliances were custom made (Figure 57).

There was insufficient evidence to assess the efficacy of non-custom OAs for improvement in QOL.

4.2.3.3 Custom, Titratable OAs vs. Custom, Non-Titratable OAs

Custom, titratable appliances improve quality of life. (Quality of Evidence: *Moderate*) Six RCTs including 2,223 patients were identified that evaluated the change in SF-36 with the use of custom, titratable OAs.[22,26,31,35,37,40] Meta-analysis (Figure 58) showed the mean reduction in SF-36 score for custom, titratable OAs to be 6.84 (95% CI: 5.42, 8.26).

Custom, non-titratable appliances do not improve quality of life in adult patients with OSA. (Quality of Evidence: *Low*) Two RCTs including 102 patients were identified that evaluated the change in SF-36 with the use of custom, non-titratable OAs.[23,28] Meta-analysis (Figure 59) showed no significant improvement in QOL for custom, non-titratable OAs; −0.95 (95% CI: −4.55, 2.64).

The evidence on the efficacy of custom, titratable and custom, non-titratable OAs for the improvement in QOL is summarized in Figures 62 and 63.

4.2.3.4 OAs vs. CPAP

OAs are nearly equivalent to CPAP for improving QOL in adult patients with OSA. (Quality of evidence: *Low*) Meta-analyses were performed on 4 RCTs that compared measures of QOL between OAs and CPAP (Figure 60) and found that

both therapies performed similarly; a clinically insignificant weighted mean improvement in SF-36 scores of 2.18 (95% CI: 1.10, 3.25) with CPAP compared to OAs.[22,28,36,40] In an RCT of patients with mild to moderate OSA, Barnes et al. compared the impact of OAs and CPAP on several functional outcomes. Both treatments led to clinically and statistically significant improvements in QOL, with greater effects noted with CPAP therapy. Neither treatment was superior to placebo for changes in neuropsychologic function or improvements in mood.[22] In an RCT, Hoekema et al. found that OAs performed similarly to CPAP in improving QOL.[36] Specifically, FOSQ scores improved from 13.7 ± 3.1 to 16.6 ± 2.8 with OAs and from 13.9 ± 3.7 to 16.7 ± 3.1 with CPAP therapy.[36] Phillips et al. observed that baseline FOSQ scores improved from 16.3 ± 0.2 to 17.3 ± 0.2 with CPAP and 17.3 ± 0.2 with an OA.[40] In addition, SF-36 scores related to Bodily Pain, Vitality, Social Function, Mental Health, and Mental Component had similar improvements with both therapies.[40]

The evidence on the efficacy of OA vs. CPAP for the improvement in QOL is presented in Figure 64.

4.2.4 Hypertension

4.2.4.1 All Appliance Types

Oral appliances have a modest impact on reducing blood pressure in adult patients with OSA. (Quality of evidence: *Moderate*) This is a new clinical question that was not addressed in the 2006 AASM Practice Parameters for the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances: An Update for 2005.[6] Since that time, several RCTs exploring the effect of OA therapy on cardiovascular outcomes, specifically blood pressure (BP) measures have been conducted.

A meta-analysis was performed on all included trials that compared pre- and post-treatment BP recordings between OAs and non-therapeutic (sham) or no treatment. The results are shown in Figures 65 and 66. In a weighted analysis, the mean reduction in systolic BP was 2.09 mmHg (95% CI: 0.96, 3.22). Oral appliances lead to a greater reduction in diastolic BP recordings, with a mean decrease of 3.15 mm Hg (95% CI: 2.03, 4.26).

Seven RCTs including 343 patients that assessed BP measures as an outcome were identified.[9,10,22,32,40,44,48] Overall, OAs were found to lower the systolic, diastolic, and mean BP. However, these reductions were modest at best. An RCT by Gotsopoulos et al. compared the effect on BP of 4 weeks of an OA vs. a non-therapeutic OA.[32] Compared to controls (non-therapeutic OA), OAs led to a 1.8 ± 0.5 mm Hg greater reduction in the mean 24-hour diastolic BP ($p = 0.001$).[32] However, there was no difference in the mean 24-hour systolic BP between the two OAs. Both systolic and diastolic BP measures during wake were improved with OAs compared to non-therapeutic controls.[32] Specifically, the mean awake systolic BP decreased by 4.4 mm Hg in those treated with OAs, compared to only 1.4 mm Hg in those receiving non-therapeutic OAs ($p = 0.003$).[32] Similarly, OA therapy produced a greater reduction in the mean diastolic BP while awake compared to controls (–3.3 mm Hg vs. –0.1 mm Hg, $p < 0.0001$).[32] Gauthier et al. observed significant reductions in BP with OA therapy, specifically, a mean reduction in diastolic BP of 10.1 mm Hg and a mean reduction in systolic BP of 4.3 mm Hg.[10] Other trials found less robust improvements in BP recordings.[22,40]

The evidence on the efficacy of OAs for the improvement in hypertension is summarized in Figure 71.

4.2.4.2 Custom vs. Non-Custom OAs

Custom OAs modestly reduce blood pressure in adult patients with OSA. (Quality of evidence: *Moderate*) The meta-analyses for all appliance types apply to custom OAs as all of the appliances were custom made (see Figures 65 and 66).

There was insufficient evidence to assess the efficacy of non-custom OAs for the reduction in BP in adult patients with OSA.

4.2.4.3 Custom, Titratable vs. Custom, Non-Titratable OAs

Custom, titratable OAs modestly reduce blood pressure in adult patients with OSA. (Quality of evidence: *Moderate*) Six RCTs including 307 patients were identified that assessed the impact of custom, titratable OAs on systolic BP.[9,10,22,32,40,44] A meta-analysis (Figure 67) of these studies showed the mean reduction in systolic BP for custom, titratable OAs to be –2.37 mm Hg (95% CI: –3.55, –1.20). In a group (n = 12) with higher baseline systolic BP, Trzepizur et al. reported decrease in mean systolic BP from 149.3 ± 3.7 to 140.5 ± 7.4 mm Hg.[44] In a larger group (n = 67) with a lower baseline systolic BP, Gotsopoulos et al. reported a modest reduction from a baseline of 127.3 ± 1.3 to 125.2 ± 1.3 mm Hg.[32]

Six RCTs including 307 patients were identified that assessed the impact of custom, titratable OAs on diastolic BP.[9,10,22,32,40,44] A meta-analysis (Figure 68) of these studies showed the mean reduction in diastolic BP for custom, titratable OAs to be –2.77 mm Hg (95% CI: –3.88, –1.67). After 2.5 to 4.5 years of treatment, Gauthier et al. reported an improvement in diastolic BP from a baseline of 92.0 ± 3.0 to 81.9 ± 2.3 mm Hg.[10] Gotsoupolos et al. reported a more modest change over a shorter treatment period from 77.7 ± 0.9 to 76.4 ± 0.9 mm Hg.[32]

Custom, non-titratable OAs modestly reduce BP in adult patients with OSA. (Quality of evidence: *High*) One RCT including 36 patients investigated changes in systolic and diastolic BP with custom, non-titratable OAs.[48] There were no significant changes found. The mean reduction in systolic BP for a custom, non-titratable OA was –2.30 mm Hg (95% CI: –7.20, 2.60). The mean reduction in diastolic BP for a custom, non-titratable OA was –2.20 mm Hg (95% CI: –6.22, 1.82).

The evidence on the efficacy of custom, titratable and custom, non-titratable OAs for the improvement in hypertension is summarized in Figures 72 and 73, respectively.

4.2.4.4 OAs vs. CPAP

OAs are nearly equivalent to CPAP in reducing blood pressure in adult patients with OSA. (Quality of evidence: *Low*) In a meta-analysis (Figures 69 and 70) of 3 RCTs comparing OA to CPAP, OAs were nearly equivalent to CPAP in lowering the systolic BP; 0.54 (95% CI: 0.32, 0.76) and diastolic BP; 0.24 (95% CI: –0.50, 0.020).[22,40,44] Trzepizur et al. reported no significant difference in post-treatment BP changes between OAs and CPAP.[44] Similarly, Phillips et al. found that neither treatment produced significant improvements in BP measures.[40]

The evidence on the efficacy of OA vs. CPAP for the improvement in hypertension is summarized in Figure 74.

4.2.5 Adherence

The adherence with oral appliances is better overall than with CPAP in adult patients with OSA. (Quality of evidence: Low) A meta-analysis was performed on 11 RCT studies (Figure 75) that evaluated the adherence rate with OA compared to CPAP, with 9 studies published since the last practice parameters paper in 2006.[22,28,30,33–36,40,44,49,50] Overall, the absolute difference between the mean subjective adherence rate for OA users was 0.70 (95% CI: 0.11, 1.30) more hours per night than the objective adherence rate among CPAP users. Though CPAP adherence was assessed objectively from the download data, OA adherence was assessed subjectively based on patients' self-reports or by reviewing self-entered information in their diaries. The adherence rate for the devices was based on 4 hours a night use, 70% of the time. There were no RCT studies that assessed OA adherence rate objectively.

Among patients randomly assigned to CPAP or OAs, Barnes et al. found CPAP was used 4.2 ± 0.3 nights/week for an average of 3.6 ± 0.3 h/night compared to 5.3 ± 0.3 nights/week for 5.5 ± 0.3 h/night with OAs.[22] Three of the 11 trials included in the meta-analysis clearly showed that adherence rates with OAs were superior to CPAP (> 1 more hour of use).[22,40,44] Seven of the remaining 8 studies also observed an increase use of OAs compared with CPAP.[28,30,33,34,36,49,50] However, these differences were less robust (less than or equal to 1 hour improvement in adherence rate compared to CPAP). It should be noted that all included trials compared subjective reports of OA use to objective measures of CPAP use. Although measures to obtain objective oral appliance adherence data do exist, they are not widely used. Therefore, few objective data exist to include in this clinical practice guideline.

The evidence comparing adherence with the use of OAs vs. CPAP is summarized in Figure 76.

4.2.6 Assessment of Side Effects

Side effects, serious enough to cause patients to discontinue use of their oral appliance, are less common than side effects causing adult patients with OSA to discontinue the use of CPAP. (Quality of evidence: *Moderate*) The purpose of follow-up is to monitor patient adherence, evaluate OA deterioration or maladjustment, evaluate the health of the oral and craniofacial structures and integrity of the occlusion, and assess the patient for signs and symptoms of worsening OSA. Intolerance and improper use of the OA are potential problems for patients using OAs, which require patient effort to use properly. OAs may aggravate temporomandibular disorder (TMD) and may cause dental misalignment and discomfort that are unique to each device. In addition, OAs can be rendered ineffective by patient alteration of the device. Specific side effects differ widely in types and severity, but most are of a dental nature: sore teeth, gum problems, sore jaw muscles, excessive salivation, difficulty chewing in the morning, dry mouth, and change in occlusion.[13,28,35,57,58] Doff et al. reported that changes in craniofacial morphology should be anticipated in OSA patients using an OA for 2 years when compared with CPAP therapy. These changes were predominantly dental in nature.[51] Long-term use of an OA resulted in small but significant dental changes compared with CPAP. In the OA group, overbite and overjet decreased 1.2 ± 1.1 mm and 1.5 ± 1.5 mm, respectively.[51] It should be noted, however, that in a prospective study conducted by Tsuda et al. to assess the craniofacial changes in adult subjects with OSA after CPAP use found that use of nasal CPAP for > 2 years resulted in a significant retrusion of the anterior maxilla, a decrease in maxillary-mandibular discrepancy, a setback of the supramentale and chin positions, a retroclination of maxillary incisors, and a decrease of convexity.[52] However, significant correlations between the craniofacial changes, demographic variables, or the duration of CPAP use could not be identified. None of the patients self-reported any permanent change of occlusion or facial profile.[52]

A meta-analysis (Figure 77) was performed on 9 studies that evaluated the discontinuation of therapy due to side effects resulting from the use of OAs.[4,21–23,29,31,35,40,43] The results showed that the odds of experiencing a side effect leading to discontinuation of therapy with OAs are 6.65:1 (95% CI: 2.51, 17.62).

A meta-analysis (Figure 78) was performed on 8 RCT studies of OAs versus CPAP and discontinuation of therapy from side effects.[4,20–22,29,35,40,43] The overall odds of discontinuing therapy due to the use of an OA vs. CPAP are 0.54:1 (95% CI: 0.26, 1.12) indicating that the risk of side effects resulting in the discontinuation of OA therapy is less than those resulting in the discontinuation of CPAP. Ferguson et al. reported that patients "had fewer side effects and greater patient satisfaction than with CPAP."[13,29] Aarab et al. reported 2 patients discontinuing OA therapy (vs. 6 patients with CPAP) because they reported experiencing more side effects than benefits.[21] The overall quality of evidence for these 8 RCT studies was moderate, with 299 patients in the OA group and 298 patients in the CPAP group. The treatment duration for all the 8 RCT studies varied from 1–12 months. A total of 14 patients withdrew from OA therapy and 25 withdrew from CPAP use.

In a study conducted by Ghazal et al., it was mentioned that "patients who complained of wearing discomfort had the fit of their OA and retention checked…PSG was carried out once the patient had tolerated the OA for at least 5 nights per week."[31] A study conducted by Rose et al. reported that subjective assessments of the OAs must be made after they are worn.[41] Patients in the study described loss of retention during the night, TMJ pain, gingival irritations, and tenderness in the masseter region.[41] More dental sessions were required for these patients.

Cunali et al. reported that temporomandibular disorder (TMD) has been the most common contraindication for OAs as a treatment for OSA.[26]

The evidence on the frequency of discontinuation of side effects from the use of OAs in adult patients with OSA is summarized in Figure 79.

The evidence comparing the frequency of occurrence of side effects with the use of OAs vs. CPAP in adult patients with OSA is summarized in Figure 80.

4.2a Recommendation: When oral appliance therapy is prescribed by a sleep physician for an adult patient with obstructive sleep apnea, we suggest that a qualified dentist use a custom, titratable appliance over non-custom oral devices. (GUIDELINE)

Values and Trade-Offs: The overall grade for the body of evidence exploring the impact of custom vs. non-custom OAs to treat OSA varies between low and moderate depending on the physiologic sleep outcome measures. A systematic review of the evidence has shown that custom, titratable OAs reduce the AHI, arousal index, and oxygen desaturation index, and increase oxygen saturation to a greater extent than do non-custom OAs. The evidence supports the use of custom, titratable OAs over other types of appliances. Although the reduction in AHI and ODI are similar for both custom, titratable and custom, non-titratable OAs, the confidence interval for the effect of the custom, titratable OAs is considerably smaller than for the custom, non-titratable appliances. Both types of custom appliances are more effective than non-custom OAs.

Neither custom nor non-custom OAs have been shown to significantly affect sleep architecture and sleep efficiency. The overall improvement in physiologic sleep parameters with the use of custom OAs in adult patients with OSA should result in an improvement in daily function and quality of life.

The available data also suggest that OAs effectively improve daytime sleepiness. The mean change in the Epworth Sleepiness Scale (ESS) with custom, titratable OAs is moderate. The reduction in subjective daytime sleepiness achieved with custom titratable OAs is not inferior to that reported with CPAP therapy. In contrast, very limited data suggest that custom, non-titratable OAs do not produce a significant change in ESS. Insufficient data are available to assess objective measures of sleepiness or wakefulness following OA therapy.

The evidence indicates that OAs are also effective in improving QOL. Specifically, custom titratable OAs provide moderate improvement in QOL outcomes. The data on QOL is very limited for custom, non-titratable OAs, therefore, their use cannot be recommended.

4.2b Recommendation: We recommend that sleep physicians consider prescription of oral appliances, rather than no treatment, for adult patients with obstructive sleep apnea who are intolerant of CPAP therapy or prefer alternate therapy. (STANDARD)

Values and Trade-Offs: CPAP is superior to OAs in the measured outcomes and, therefore, should be the first-line option for treating OSA. A review of the evidence suggests that adherence rates using OAs are greater than those observed with CPAP. However, no randomized controlled trials have assessed objective OA adherence rate as compared with CPAP. The subjective reporting of adherence rate is prone to bias and needs to be interpreted with caution, as patients may overestimate their OA use. However, a patient whose OSA does not improve with the use of CPAP or is intolerant to CPAP may benefit from the use of an OA. Overall, the discontinuation of therapy due to side effects occurs less when using OAs versus CPAP to treat adult patients with OSA. Therefore, OAs can be offered to patients with OSA who strongly prefer alternate therapies due to side effects or inability to use CPAP.

OAs were not compared to other alternate therapies as there were not sufficient head-to-head studies to analyze.

The overall grade for the body of evidence on the impact of OAs to treat obstructive sleep apnea (OSA) varies between low and moderate depending on the physiologic sleep outcome measures. A systematic review of the evidence has shown that OAs reduce AHI, arousal index, oxygen desaturation index, and increase oxygen saturation. However, OAs have shown no significant effect on sleep architecture and sleep efficiency. The overall improvement in physiologic sleep parameters with the use of OAs in adult patients with OSA should result in an improvement in daily function and quality of life. Although OAs have been shown to improve physiologic sleep parameters, CPAP appears, in our meta-analyses, to be superior to OAs in reducing the AHI, arousal index, and oxygen desaturation index and improving oxygen saturation, and therefore should still generally be the first-line option for treating OSA. The improvement in QOL produced by custom, titratable OAs is not inferior to that reported with CPAP therapy. The quality of evidence for the use of these OAs to improve QOL is moderate, whereas the quality of evidence comparing OAs to CPAP is low. The custom, titratable OAs improve QOL, but as with CPAP, reduced QOL may persist despite otherwise adequate therapy.

The available data regarding the impact of OAs on blood pressure are more limited (overall grade for the body of evidence is low) than the data addressing blood pressure change with CPAP. For example, the role of OAs in patients with resistant hypertension has not yet been evaluated. However, the available data suggest that OAs may be as effective as CPAP in at least select patient populations to lower blood pressure and, therefore, should not preclude the use of either therapy or diminish the other established benefits that accrue from treatment of OSA. Of note, no RCTs have assessed the impact of OA therapy on other cardiovascular endpoints.

In summary, OAs may be effective in improving sleep parameters and outcomes of OSA, and there is little likelihood of harm. Although they are not as effective as PAP therapy, the benefits of using OAs outweigh risks of not using OAs. Thus, a STANDARD strength of recommendation to use OAs was provided.

4.2c Recommendation: We suggest that qualified dentists provide oversight—rather than no follow-up—of oral appliance therapy in adult patients with obstructive sleep apnea, to survey for dental-related side effects or occlusal changes and reduce their incidence. (GUIDELINE)

Values and Trade-Offs: Beneficial treatment effects may be reduced by treatment-related side effects, and most OA therapy side effects are dental. A wide range of devices made from a variety of materials and having different characteristics, are utilized in clinical practice. Literature on dentists performing interventions to prevent failure of OA therapy is limited, although the topic is mentioned in the results and discussion sections of some publications. Therefore, the overall evidence in support of the above recommendation was considered low. Nevertheless, minimization of side effects may improve adherence and thereby patient outcomes. Several studies demonstrated dental interventions to mitigate side effects. Additionally, knowledge of dental materials and a variety of dental devices including the knowledge of the patients' dental status will likely ensure fewer side effects. A

qualified dentist will be able to screen for many problems and choose and/or build the OA with features to minimize the side effects of the therapy. A qualified dentist will have the skills to choose the proper OA and make necessary modifications to accommodate patients who, among other things, may have allergies to metals or acrylics, are strong teeth grinders, or have anatomical deviations. The patient's history and exam, appliance preference, and review of any side effects should be taken into account to avoid device breakage, allergic reactions, or discomfort that leads to frustration or discontinuation of the therapy.

4.2.7 Long-term Management

Follow-up evaluations and sleep testing improves long-term management of adult patients with OSA. (Quality of evidence: *Low*) Although insufficient data was attained to produce a meta-analysis, several studies demonstrated that adjustments made to the OA, based on data obtained from PSGs and home sleep apnea tests (a 7-channel unattended test recording chest and abdominal movement, oxygen saturation, oro-nasal airflow, heart rate, body position, and parapharyngeal noise was utilized by Rose et al.), resulted in greater success.[41] Gagnadoux et al. compared CPAP and OAs after one-night PSG titration of both treatments. Titration of the OA was designed to optimize its efficacy. The results showed a 70% success with OA therapy vs. an 82% success with CPAP.[30] In a study conducted by Hoekema et al., participants used an OA (or CPAP) for 8 weeks, and the effect was assessed with a PSG.[36] For those with an AHI ≥ 5, the OA was adjusted and another PSG was performed. This sequence was repeated until the AHI was < 5 or the adjustments caused discomfort. Of the total OA population 76.5% were effectively treated (69.2% of the severe patients were considered effectively treated and 84.0% of the non-severe patients were considered effectively treated).[36] Aarab et al. demonstrated that, through PSG, an effective reduction in AHI was seen at 25% (1 patient), 50% (7 patients) and at 75% (12 patients).[21]

4.2d Recommendation: We suggest that sleep physicians conduct follow-up sleep testing to improve or confirm treatment efficacy, rather than conduct follow-up without sleep testing, for patients fitted with oral appliances. (GUIDELINE)

Values and Trade-Offs: The overall grade of evidence for support of follow-up evaluations and testing by sleep physicians is low due to a lack of evidence. However, the discussion sections in most research studies report significant improvement in OA effectiveness when changes were made to the appliances based on data obtained either during or after the sleep studies. While insufficient evidence exists to produce a meta-analysis, the available data suggest that subjective feedback is not sufficient to determine the optimal setting of the OA in the management of OSA. Without objective data the patient may, unnecessarily, remain suboptimally treated. Follow-up sleep testing by sleep physicians should also be considered for OA-treated patients who develop recurrent symptoms, show substantial weight changes, or receive diagnoses of comorbidities relevant to OSA.

4.2e Recommendation: We suggest that sleep physicians and qualified dentists instruct adult patients treated with oral appliances for obstructive sleep apnea to return for periodic office visits—as opposed to no follow-up—with a qualified dentist and a sleep physician. (GUIDELINE)

Values and Trade-Offs: A review of the evidence suggests that patients may benefit from periodic follow-up visits with a physician and with a qualified dentist. Several studies have demonstrated that adjustments made to the OA by a dentist, based on data obtained from PSGs and home sleep apnea tests conducted by a physician, may result in greater long-term improvement in OSA. The absence of periodic follow-up visits may result in suboptimal improvement in OSA or side effects that increase risk for discontinuation of therapy.

5.0 FUTURE DIRECTIONS

Since the publication of the previous practice parameters on the use of OAs for the management of OSA, a considerable amount of literature has been published on the efficacy of OA treatment using different types of appliances. Nevertheless, there are a number of unresolved issues that require additional consideration. Suggestions for future research are summarized below.

- There should be a consistent and standardized nomenclature when referring to OAs. We suggest that future studies should use the term "oral appliance" rather than use terms such as splints.
- Future studies should consider clinically relevant protocols when assessing custom, non-titratable OAs and when comparing different types of OAs. Methods that use more than one non-titratable OA at difference protrusive positions, or cut apart and reposition appliances do not replicate the methods clinicians expect to use with non-titratable OAs. Clinicians expect to fabricate a non-titratable OA at one protrusive position and leave it there for the course of treatment. Titration protocols that use a titratable OA during sleep to pre-determine an effective protrusive position prior to the fabrication of a non-titratable OA may be valuable.
- As the current data indicate benefits with custom titratable OAs to treat OSA compared to other types of OAs, future studies evaluating outcome measures related to OSA treatment should consider using only custom titratable OAs to compare with other therapies such as CPAP.
- A consistent and objective measure of snoring is needed when evaluating treatment benefit.
- Standard protocols are needed to document adverse effects related to OAs.
- Subjective reporting of adherence by patients is the current method of assessing OA adherence. As this is prone for reporting bias and with a lack of randomized control trials assessing objective OA use, future efforts and studies are needed to obtain objective OA adherence data, similar to CPAP. There are several recent non-RCTs published that report on the use of objective adherence

monitors in OAs. Further RCTs are needed to evaluate the efficacy of these monitors and also to compare it with the CPAP objective adherence rate.

- Larger and longer RCTs examining the benefits of OA treatment to cardiac, metabolic, and neurocognitive health will also be valuable to clinicians contemplating OA treatment for their patients.
- Studies are needed to assess the long-term outcomes associated with OA therapy in adult patients with OSA.
- Current data demonstrates that mild side effects are associated with OA therapy when compared to CPAP therapy. Few research studies conduct head to head comparisons of devices and many devices have little research investigating side effects at this time. Further research demonstrating an association between specific devices and associated side effects would be useful.
- While evidence is low in assessing the relationship of dental involvement, side effects, and adherence to OA therapy, the discussion section of many RCTs describe incidences of patients requiring additional follow up visits with dentists to make the OAs more comfortable. It is reasonable to conclude that a mitigation of side effects will increase patient adherence with therapy. There were no RCT studies assessing objective OA adherence rate because reliable technology was not available until recently. The subjectively reported adherence in RCTs is prone to bias. Future studies, utilizing newly developed technologies that produce objective data are needed.
- Studies are needed to assess the effects of mandibular exercises and other methods to mitigate side effects associated with OAs.
- Knowing the predictive factors for OA success to treat OSA will be helpful for a clinician. However, studies to date have had significant study methodology limitations, resulting in predictive factors that are not consistent in all studies. Also, some of these factors cannot be readily accessed or be used by the clinician. Future studies evaluating for predictive factors for success of OSA treatment with OAs are needed, and ideally these factors should be readily accessed and applied by the clinician.
- Also, future studies evaluating cost benefit analysis and effectiveness are needed compared to CPAP.

While significant progress has been made in defining an effective OA for the treatment of patients with OSA, this guideline underscores the need to enhance the quantity, quality, and scope of future studies to optimize patient care strategies.

NOTES

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APPENDIX

Meta-Analyses and GRADE Summary of Findings Reports

Figure 1—Custom, Non-Titratable (C-NT) OAs for Mild to Moderate Adult OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Randerath 2002	10.5	7.5	20	17.5	7.7	20	34.8%	-7.00 [-11.71, -2.29]
Rose 2002	5.5	3.3	20	16.2	4.6	20	65.2%	-10.70 [-13.18, -8.22]
Total (95% CI)			**40**			**40**	**100.0%**	**-9.41 [-12.87, -5.96]**

Heterogeneity: Tau² = 3.16; Chi² = 1.86, df = 1 (P = 0.17); I² = 46%
Test for overall effect: Z = 5.34 (P < 0.00001)

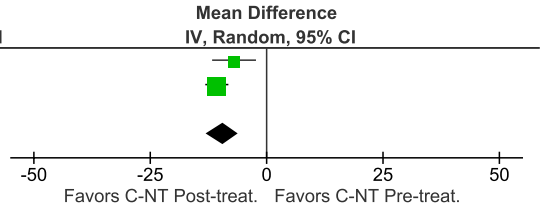

Figure 2—Custom, Non-Titratable OAs for Moderate to Severe Adult OSA (AHI/RDI/REI).

Study or Subgroup	C-NT post-treatment Mean	SD	Total	C-NT pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Bloch 2000	7.9	1.6	24	22.6	3.1	24	51.7%	-14.70 [-16.10, -13.30]
Zhou 2012	6.6	2.3	16	26.4	4.1	16	48.3%	-19.80 [-22.10, -17.50]
Total (95% CI)			**40**			**40**	**100.0%**	**-17.16 [-22.16, -12.17]**

Heterogeneity: Tau² = 12.06; Chi² = 13.77, df = 1 (P = 0.0002); I² = 93%
Test for overall effect: Z = 6.73 (P < 0.00001)

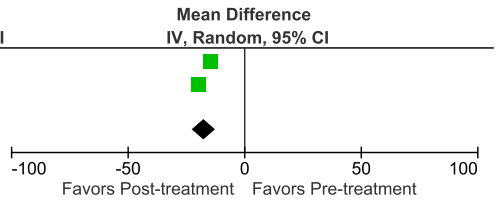

Figure 3—Custom, Titratable (C-T) OAs for Mild to Moderate Adult OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Gauthier 2009	6.5	1.3	16	10	1.2	16	28.8%	-3.50 [-4.37, -2.63]
Gauthier 2009	4.7	0.9	16	10	1.2	16	29.8%	-5.30 [-6.03, -4.57]
Gauthier 2011	4.5	0.7	14	10.4	1.3	14	29.5%	-5.90 [-6.67, -5.13]
Rose 2002	7.4	5.3	18	16	4.4	18	11.8%	-8.60 [-11.78, -5.42]
Total (95% CI)			**64**			**64**	**100.0%**	**-5.35 [-6.71, -3.98]**

Heterogeneity: Tau² = 1.49; Chi² = 22.12, df = 3 (P < 0.0001); I² = 86%
Test for overall effect: Z = 7.66 (P < 0.00001)

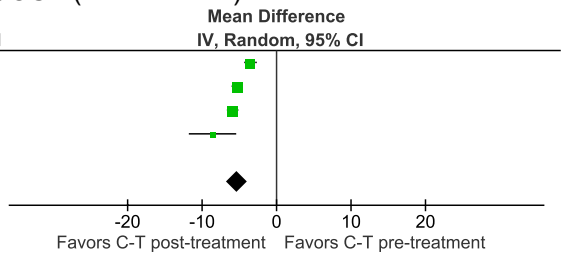

Figure 4—Custom, Titratable OAs for Moderate to Severe Adult OSA (AHI/RDI/REI).

Study or Subgroup	C-T post-treatment Mean	SD	Total	C-T pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Bloch 2000	8.7	1.5	24	22.6	3.1	24	37.4%	-13.90 [-15.28, -12.52]
Ghazal 2009	8.7	11.6	47	23	18.2	47	10.6%	-14.30 [-20.47, -8.13]
Ghazal 2009	7	13.6	48	22	21.3	48	8.4%	-15.00 [-22.15, -7.85]
Lawton 2005	34	13.5	15	45.5	9.8	15	6.4%	-11.50 [-19.94, -3.06]
Lawton 2005	24.5	11.2	16	45.5	9.8	16	8.2%	-21.00 [-28.29, -13.71]
Zhou 2012	8.9	2.9	16	26.4	4.1	16	29.0%	-17.50 [-19.96, -15.04]
Total (95% CI)			**166**			**166**	**100.0%**	**-15.51 [-17.82, -13.19]**

Heterogeneity: Tau² = 3.25; Chi² = 9.65, df = 5 (P = 0.09); I² = 48%
Test for overall effect: Z = 13.12 (P < 0.00001)

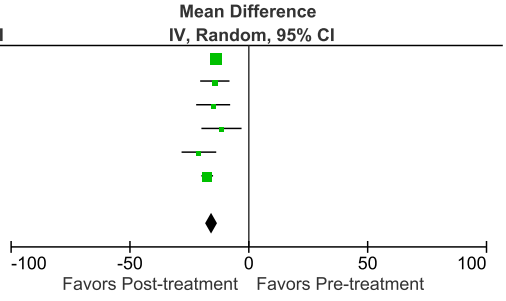

Figure 5—CPAP for Mild to Moderate Adult OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Lam 2007	2.8	1.1	34	23.8	1.9	34	53.6%	-21.00 [-21.74, -20.26]
Randerath 2002	3.2	2.9	20	17.5	7.7	20	46.4%	-14.30 [-17.91, -10.69]
Total (95% CI)			**54**			**54**	**100.0%**	**-17.89 [-24.44, -11.34]**

Heterogeneity: Tau² = 20.68; Chi² = 12.73, df = 1 (P = 0.0004); I² = 92%
Test for overall effect: Z = 5.35 (P < 0.00001)

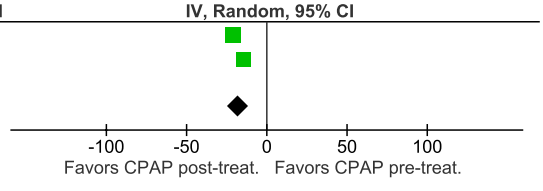

Figure 6—CPAP for Severe Adult OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Trzepizur 2009	2	5.2	12	40	13.3	12	100.0%	-38.00 [-46.08, -29.92]
Total (95% CI)			**12**			**12**	**100.0%**	**-38.00 [-46.08, -29.92]**

Heterogeneity: Not applicable
Test for overall effect: Z = 9.22 (P < 0.00001)

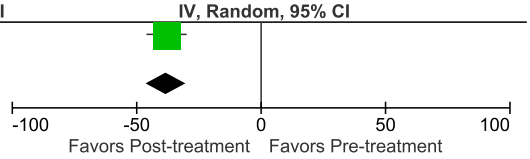

Figure 7—OAs for Primary Snoring (Snoring Loudness).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Cooke 2006	6	2	22	8.5	1	22	46.1%	-2.50 [-3.43, -1.57]
Johnston 2001	2.5	0.97	25	6.5	0.59	25	53.9%	-4.00 [-4.45, -3.55]
Total (95% CI)			**47**			**47**	**100.0%**	**-3.31 [-4.77, -1.84]**

Heterogeneity: Tau² = 0.99; Chi² = 8.07, df = 1 (P = 0.005); I² = 88%
Test for overall effect: Z = 4.42 (P < 0.00001)

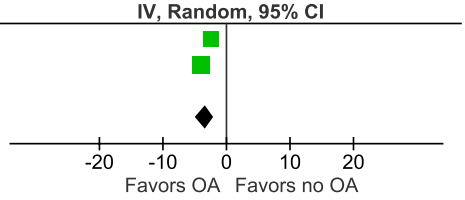

Figure 8—Summary of Findings (Primary Snoring, Snoring Indices).

Oral Appliances (OAs) for Primary Snoring

Patient or population: Patients with Primary Snoring
Intervention: OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**OAs**				
Snoring (snores/h)		The mean snoring (snores/h) in the intervention groups was **278 lower** (375.3 to 180.7 lower)		11 (1 study)	⊕⊕⊕⊕ **high**	
Snoring (nights/wk)		The mean snoring (nights/wk) in the intervention groups was **1.9 lower** (1.32 to 2.48 lower)		25 (1 study)	⊕⊕⊕⊕ **high**	
Snoring loudness (1-10 VAS)		The mean snoring loudness (1-10 VAS) in the intervention groups was **3.31 lower** (4.77 to 1.84 lower)		47 (2 studies)	⊕⊕⊕⊕ **high**	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Figure 9—OAs for OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	5.8	14.9	20	22.1	10.8	20	1.9%	-16.30 [-24.37, -8.23]
Aarab 2011b	6.4	15.2	15	21.4	11	21	1.7%	-15.00 [-24.02, -5.98]
Barnes 2004	14	1.1	85	21.3	1.3	85	3.3%	-7.30 [-7.66, -6.94]
Blanco 2005	9.6	12.1	8	33.8	14.7	8	1.1%	-24.20 [-37.39, -11.01]
Bloch 2000	8.7	1.5	24	22.6	3.1	24	3.2%	-13.90 [-15.28, -12.52]
Bloch 2000	7.9	1.6	24	22.6	3.1	24	3.2%	-14.70 [-16.10, -13.30]
Campbell 2009	14.3	9.8	16	25.4	7.4	16	2.3%	-11.10 [-17.12, -5.08]
Campbell 2009	11.7	10	12	26.5	12	12	1.7%	-14.80 [-23.64, -5.96]
Cunali 2011	9	7	29	16	8	29	2.8%	-7.00 [-10.87, -3.13]
Deane 2009	12	9	22	27	17.2	22	1.8%	-15.00 [-23.11, -6.89]
Engleman 2002	15	16	48	31	26	48	1.7%	-16.00 [-24.64, -7.36]
Ferguson 1996	9.7	7.3	19	19.7	13.8	19	2.1%	-10.00 [-17.02, -2.98]
Ferguson 1997	14.2	14.7	20	25.3	15	20	1.6%	-11.10 [-20.30, -1.90]
Gagnadoux 2009	6	8.2	56	34.2	13	56	2.8%	-28.20 [-32.23, -24.17]
Gauthier 2009	4.7	0.9	16	10	1.2	16	3.3%	-5.30 [-6.03, -4.57]
Gauthier 2009	6.5	1.3	16	10	1.2	16	3.3%	-3.50 [-4.37, -2.63]
Gauthier 2011	4.5	0.7	14	10.4	1.3	14	3.3%	-5.90 [-6.67, -5.13]
Ghazal 2009	5.3	15.6	48	21	24.4	48	1.8%	-15.70 [-23.89, -7.51]
Ghazal 2009	8.7	11.6	47	23	18.2	47	2.3%	-14.30 [-20.47, -8.13]
Gotsopoulos 2002	12	2	73	27	2	73	3.3%	-15.00 [-15.65, -14.35]
Gotsopoulos 2004	12	2	67	27	15	67	2.9%	-15.00 [-18.62, -11.38]
Hoekema 2007a	3.2	6.5	20	20.4	16	20	2.0%	-17.20 [-24.77, -9.63]
Hoekema 2007b	5.2	7.2	9	50	59.7	9	0.2%	-44.80 [-84.09, -5.51]
Hoekema 2008a	4	6.9	12	31	9.3	12	2.2%	-27.00 [-33.55, -20.45]
Hoekema 2008b	7.8	14.4	51	39.4	30.8	51	1.6%	-31.60 [-40.93, -22.27]
Johnston 2002	22.9	22.8	20	31.9	21.2	20	1.0%	-9.00 [-22.64, 4.64]
Lawton 2005	34	13.5	15	45.5	9.8	15	1.8%	-11.50 [-19.94, -3.06]
Lawton 2005	24.5	11.2	16	45.5	9.8	16	2.0%	-21.00 [-28.29, -13.71]
Mehta 2001	14	2	28	30	2	28	3.3%	-16.00 [-17.05, -14.95]
Naismith 2005	12.2	12.3	73	26.9	15.4	73	2.7%	-14.70 [-19.22, -10.18]
Phillips 2013	11.1	12.1	126	25.6	12.3	126	3.0%	-14.50 [-17.51, -11.49]
Randerath 2002	13.8	11.1	20	17.5	7.7	20	2.3%	-3.70 [-9.62, 2.22]
Rose 2002	5.5	3.3	20	16.2	4.6	20	3.1%	-10.70 [-13.18, -8.22]
Rose 2002	7.4	5.3	18	16	4.4	18	3.0%	-8.60 [-11.78, -5.42]
Sutherland 2011	12	12.6	39	26.9	17.1	39	2.2%	-14.90 [-21.57, -8.23]
Tan 2002	8	10.9	24	22.2	9.6	24	2.4%	-14.20 [-20.01, -8.39]
Tzepizur 2009	14	8.2	12	40	13.3	12	1.7%	-26.00 [-34.84, -17.16]
Vanderveken 2008	11	9	23	14	12	23	2.3%	-3.00 [-9.13, 3.13]
Vanderveken 2008	6	8	23	14	12	23	2.3%	-8.00 [-13.89, -2.11]
Wilhelmsson 1999	6	1.5	41	18.2	1.2	41	3.3%	-12.20 [-12.79, -11.61]
Zhou 2012	6.6	2.3	16	26.4	4.1	16	3.1%	-19.80 [-22.10, -17.50]
Zhou 2012	9.9	2.9	16	26.4	4.1	16	3.1%	-16.50 [-18.96, -14.04]
Total (95% CI)			**1301**			**1307**	**100.0%**	**-13.59 [-15.25, -11.94]**

Heterogeneity: Tau² = 21.47; Chi² = 1461.67, df = 41 (P < 0.00001); I² = 97%
Test for overall effect: Z = 16.09 (P < 0.00001)

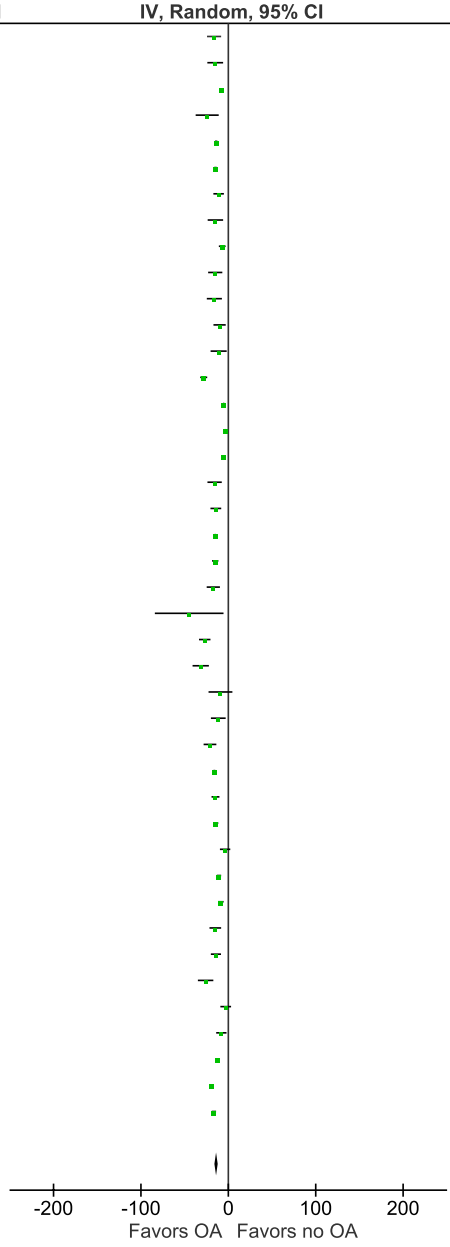

Figure 10—Custom OAs for OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	5.8	14.9	20	22.1	10.8	20	1.9%	-16.30 [-24.37, -8.23]
Aarab 2011b	6.4	15.2	15	21.4	11	21	1.7%	-15.00 [-24.02, -5.98]
Barnes 2004	14	1.1	85	21.3	1.3	85	3.5%	-7.30 [-7.66, -6.94]
Blanco 2005	9.6	12.1	8	33.8	14.7	8	1.1%	-24.20 [-37.39, -11.01]
Bloch 2000	7.9	1.6	24	22.6	3.1	24	3.4%	-14.70 [-16.10, -13.30]
Bloch 2000	8.7	1.5	24	22.6	3.1	24	3.4%	-13.90 [-15.28, -12.52]
Campbell 2009	11.7	10	12	26.5	12	12	1.8%	-14.80 [-23.64, -5.96]
Campbell 2009	14.3	9.8	16	25.4	7.4	16	2.4%	-11.10 [-17.12, -5.08]
Cunali 2011	9	7	29	16	8	29	2.9%	-7.00 [-10.87, -3.13]
Deane 2009	12	9	22	27	17.2	22	1.9%	-15.00 [-23.11, -6.89]
Engleman 2002	15	16	48	31	26	48	1.8%	-16.00 [-24.64, -7.36]
Ferguson 1997	14.2	14.7	20	25.3	15	20	1.7%	-11.10 [-20.30, -1.90]
Gagnadoux 2009	6	8.2	56	34.2	13	56	2.9%	-28.20 [-32.23, -24.17]
Gauthier 2009	4.7	0.9	16	10	1.2	16	3.4%	-5.30 [-6.03, -4.57]
Gauthier 2009	6.5	1.3	16	10	1.2	16	3.4%	-3.50 [-4.37, -2.63]
Gauthier 2011	4.5	0.7	14	10.4	1.3	14	3.4%	-5.90 [-6.67, -5.13]
Ghazal 2009	8.7	11.6	47	23	18.2	47	2.4%	-14.30 [-20.47, -8.13]
Ghazal 2009	5.3	15.6	48	21	24.4	48	1.9%	-15.70 [-23.89, -7.51]
Gotsopoulos 2002	12	2	73	27	2	73	3.4%	-15.00 [-15.65, -14.35]
Gotsopoulos 2004	12	2	67	27	15	67	3.0%	-15.00 [-18.62, -11.38]
Hoekema 2007a	3.2	6.5	20	20.4	16	20	2.0%	-17.20 [-24.77, -9.63]
Hoekema 2007b	5.2	7.2	9	50	59.7	9	0.2%	-44.80 [-84.09, -5.51]
Hoekema 2008a	4	6.9	12	31	9.3	12	2.3%	-27.00 [-33.55, -20.45]
Hoekema 2008b	7.8	14.4	51	39.4	30.8	51	1.7%	-31.60 [-40.93, -22.27]
Johnston 2002	22.9	22.8	20	31.9	21.2	20	1.1%	-9.00 [-22.64, 4.64]
Lawton 2005	34	13.5	15	45.5	9.8	15	1.9%	-11.50 [-19.94, -3.06]
Lawton 2005	24.5	11.2	16	45.5	9.8	16	2.1%	-21.00 [-28.29, -13.71]
Mehta 2001	14	2	28	30	2	28	3.4%	-16.00 [-17.05, -14.95]
Naismith 2005	12.2	12.3	73	26.9	15.4	73	2.8%	-14.70 [-19.22, -10.18]
Phillips 2013	11.1	12.1	126	25.6	12.3	126	3.1%	-14.50 [-17.51, -11.49]
Randerath 2002	13.8	11.1	20	17.5	7.7	20	2.4%	-3.70 [-9.62, 2.22]
Rose 2002	5.5	3.3	20	16.2	4.6	20	3.2%	-10.70 [-13.18, -8.22]
Rose 2002	7.4	5.3	18	16	4.4	18	3.1%	-8.60 [-11.78, -5.42]
Sutherland 2011	12	12.6	39	26.9	17.1	39	2.2%	-14.90 [-21.57, -8.23]
Tan 2002	8	10.9	24	22.2	9.6	24	2.5%	-14.20 [-20.01, -8.39]
Tzepizur 2009	14	8.2	12	40	13.3	12	1.8%	-26.00 [-34.84, -17.16]
Vanderveken 2008	6	8	23	14	1.2	23	3.1%	-8.00 [-11.31, -4.69]
Wilhelmsson 1999	6	1.5	41	18.2	1.2	41	3.4%	-12.20 [-12.79, -11.61]
Zhou 2012	6.6	2.3	16	26.4	4.1	16	3.2%	-19.80 [-22.10, -17.50]
Zhou 2012	9.9	2.9	16	26.4	4.1	16	3.2%	-16.50 [-18.96, -14.04]
Total (95% CI)			**1259**			**1265**	**100.0%**	**-13.89 [-15.57, -12.20]**

Heterogeneity: Tau² = 21.42; Chi² = 1457.86, df = 39 (P < 0.00001); I² = 97%
Test for overall effect: Z = 16.14 (P < 0.00001)

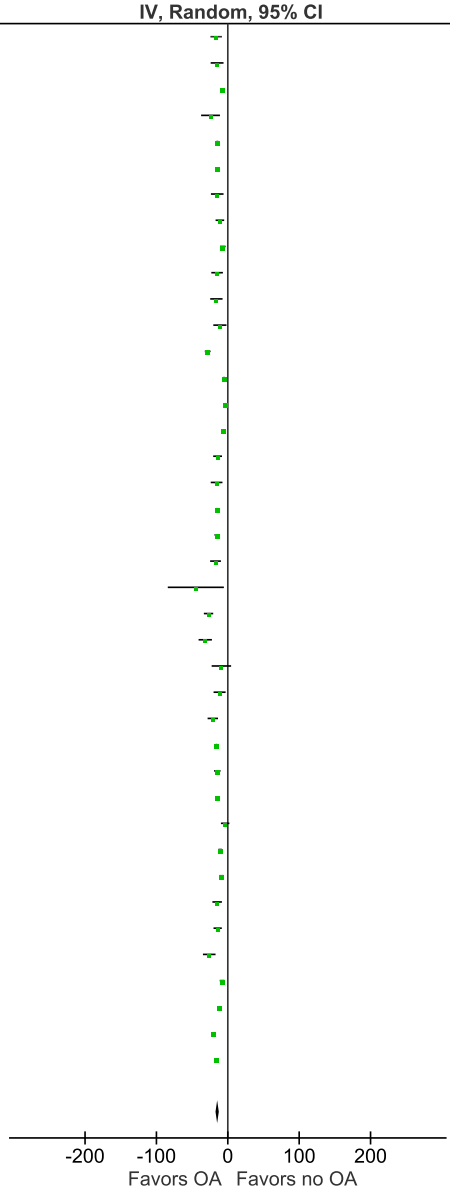

Figure 11—Non-Custom OAs for OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ferguson 1996	9.7	7.3	19	19.7	13.8	19	46.9%	-10.00 [-17.02, -2.98]
Vanderveken 2008	11	9	23	14	12	23	53.1%	-3.00 [-9.13, 3.13]
Total (95% CI)			**42**			**42**	**100.0%**	**-6.28 [-13.13, 0.56]**

Heterogeneity: Tau² = 13.19; Chi² = 2.17, df = 1 (P = 0.14); I² = 54%
Test for overall effect: Z = 1.80 (P = 0.07)

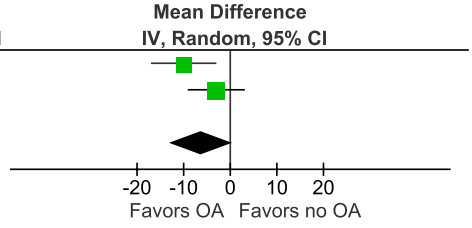

Figure 12—Custom, Titratable OAs for OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	5.8	14.9	20	22.1	10.8	20	2.4%	-16.30 [-24.37, -8.23]
Aarab 2011b	6.4	15.2	15	21.4	11	21	2.2%	-15.00 [-24.02, -5.98]
Barnes 2004	14	1.1	85	21.3	1.3	85	4.2%	-7.30 [-7.66, -6.94]
Bloch 2000	8.7	1.5	24	22.6	3.1	24	4.1%	-13.90 [-15.28, -12.52]
Campbell 2009	14.3	9.8	16	25.4	7.4	16	3.0%	-11.10 [-17.12, -5.08]
Campbell 2009	11.7	10	12	26.5	12	12	2.2%	-14.80 [-23.64, -5.96]
Cunali 2011	9	7	29	16	8	29	3.6%	-7.00 [-10.87, -3.13]
Deane 2009	12	9	22	27	17.2	22	2.4%	-15.00 [-23.11, -6.89]
Ferguson 1997	14.2	14.7	20	25.3	15	20	2.2%	-11.10 [-20.30, -1.90]
Gagnadoux 2009	7.2	8.1	59	34.2	13	59	3.6%	-27.00 [-30.91, -23.09]
Gauthier 2009	6.5	1.3	16	10	1.2	16	4.2%	-3.50 [-4.37, -2.63]
Gauthier 2009	4.7	0.9	16	10	1.2	16	4.2%	-5.30 [-6.03, -4.57]
Gauthier 2011	4.5	0.7	14	10.4	1.3	14	4.2%	-5.90 [-6.67, -5.13]
Ghazal 2009	7.9	15.6	48	22.2	24.4	48	2.4%	-14.30 [-22.49, -6.11]
Ghazal 2009	8.4	11.6	47	21.4	18.2	47	2.9%	-13.00 [-19.17, -6.83]
Gotsopoulos 2002	12	2	73	27	2	73	4.2%	-15.00 [-15.65, -14.35]
Gotsopoulos 2004	12	2	67	27	15	67	3.7%	-15.00 [-18.62, -11.38]
Hoekema 2007a	3.2	6.5	20	20.4	16	20	2.6%	-17.20 [-24.77, -9.63]
Hoekema 2007b	5.2	7.2	9	50	62.4	9	0.2%	-44.80 [-85.84, -3.76]
Hoekema 2008a	4	6.9	12	31	9.3	12	2.8%	-27.00 [-33.55, -20.45]
Hoekema 2008b	7.8	14.4	47	39.4	30.8	51	2.1%	-31.60 [-41.00, -22.20]
Lawton 2005	35	10	15	47	9.6	16	2.7%	-12.00 [-18.91, -5.09]
Lawton 2005	23.5	8.3	16	47	9.6	16	2.9%	-23.50 [-29.72, -17.28]
Mehta 2001	14	2	28	30	2	28	4.1%	-16.00 [-17.05, -14.95]
Naismith 2005	12.2	12.3	73	26.9	15.4	73	3.4%	-14.70 [-19.22, -10.18]
Phillips 2013	11.1	12.1	126	25.6	12.3	126	3.8%	-14.50 [-17.51, -11.49]
Randerath 2002	13.8	11.1	20	17.5	7.7	20	3.0%	-3.70 [-9.62, 2.22]
Rose 2002	5.5	3.3	20	16.2	4.6	20	3.9%	-10.70 [-13.18, -8.22]
Rose 2002	7.4	5.3	18	16	4.4	18	3.8%	-8.60 [-11.78, -5.42]
Sutherland 2011	12	12.6	39	26.9	17.1	39	2.8%	-14.90 [-21.57, -8.23]
Trzepizur 2009	14	8.2	12	40	13.3	12	2.2%	-26.00 [-34.84, -17.16]
Zhou 2012	9.9	2.9	16	26.4	4.1	16	3.9%	-16.50 [-18.96, -14.04]
Total (95% CI)			**1054**			**1065**	**100.0%**	**-13.80 [-15.74, -11.87]**

Heterogeneity: Tau² = 23.22; Chi² = 1207.31, df = 31 (P < 0.00001); I² = 97%
Test for overall effect: Z = 13.98 (P < 0.00001)

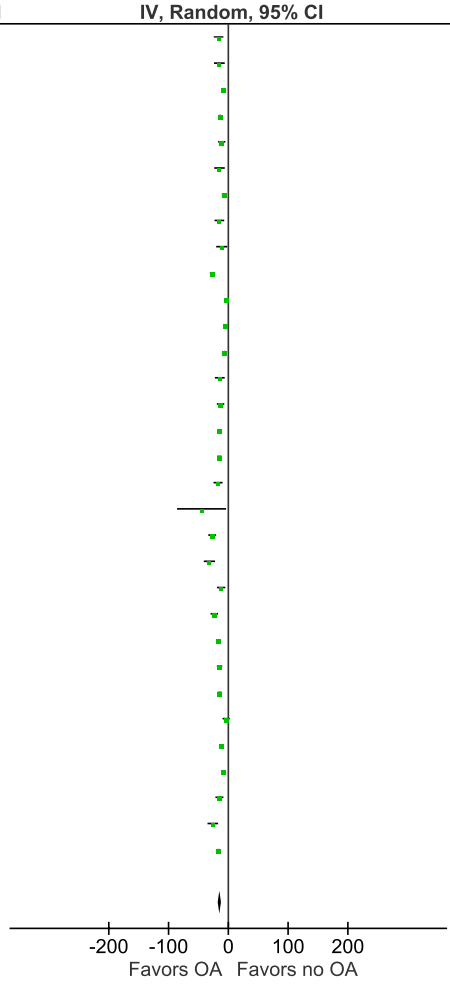

Figure 13—Custom, Non-Titratable OAs for OSA (AHI/RDI/REI).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Blanco 2005	9.6	12.1	8	33.8	14.7	8	3.8%	-24.20 [-37.39, -11.01]
Bloch 2000	7.9	1.6	24	22.6	3.1	24	34.5%	-14.70 [-16.10, -13.30]
Engleman 2002	15	16	48	31	26	48	7.8%	-16.00 [-24.64, -7.36]
Johnston 2002	22.9	22.8	20	31.9	21.2	20	3.6%	-9.00 [-22.64, 4.64]
Vanderveken 2008	11	9	23	14	12	23	12.9%	-3.00 [-9.13, 3.13]
Wilhelmsson 1999	6	1.5	41	18.2	1.2	41	37.3%	-12.20 [-12.79, -11.61]
Total (95% CI)			**164**			**164**	**100.0%**	**-12.51 [-15.23, -9.80]**

Heterogeneity: Tau² = 5.06; Chi² = 23.66, df = 5 (P = 0.0003); I² = 79%
Test for overall effect: Z = 9.03 (P < 0.00001)

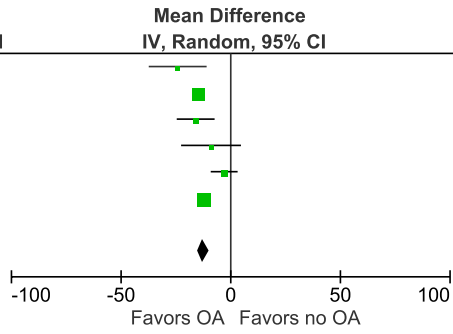

Figure 14—OAs vs. CPAP for OSA (AHI/RDI/REI).

Study or Subgroup	OA Mean	OA SD	OA Total	CPAP Mean	CPAP SD	CPAP Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	5.8	14.9	20	1.4	13.1	18	3.2%	4.40 [-4.50, 13.30]
Aarab 2011b	6.4	15.2	15	0	12.4	13	2.6%	6.40 [-3.83, 16.63]
Barnes 2004	14	1.1	85	4.8	0.5	85	11.0%	9.20 [8.94, 9.46]
Engleman 2002	15	16	48	8	6	48	6.4%	7.00 [2.17, 11.83]
Ferguson 1996	14.2	14.7	20	4	2.2	20	4.8%	10.20 [3.69, 16.71]
Ferguson 1997	9.7	7.3	19	3.6	1.7	20	8.2%	6.10 [2.73, 9.47]
Gagnadoux 2009	6	8.2	28	2	5.2	29	7.9%	4.00 [0.42, 7.58]
Hoekema 2007a	3.2	6.5	27	1.6	3.1	20	8.9%	1.60 [-1.20, 4.40]
Hoekema 2007b	5.2	7.2	9	0	3.6	10	6.0%	5.20 [-0.01, 10.41]
Hoekema 2008a	4	6.9	12	2.6	4.7	13	6.6%	1.40 [-3.27, 6.07]
Hoekema 2008b	7.8	14.4	47	2.4	4.2	47	7.1%	5.40 [1.11, 9.69]
Phillips 2013	11.1	12.1	108	4.5	6.6	108	9.1%	6.60 [4.00, 9.20]
Randerath 2002	13.8	11.1	20	3.2	2.9	20	6.2%	10.60 [5.57, 15.63]
Tan 2002	8	10.9	21	3.1	2.8	21	6.5%	4.90 [0.09, 9.71]
Tzepizur 2009	14	8.2	12	2	5.2	9	5.5%	12.00 [6.25, 17.75]
Total (95% CI)			**491**			**481**	**100.0%**	**6.24 [4.34, 8.14]**

Heterogeneity: Tau² = 8.56; Chi² = 63.94, df = 14 (P < 0.00001); I² = 78%
Test for overall effect: Z = 6.43 (P < 0.00001)

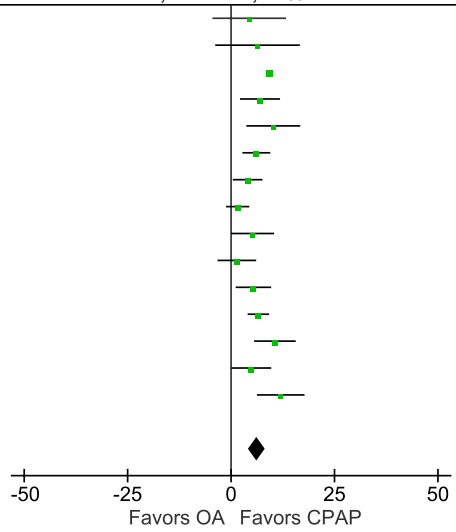

Figure 15—OAs for OSA (Minimum Oxygen Saturation).

Study or Subgroup	Post-treatment Mean	Post-treatment SD	Post-treatment Total	Pre-treatment Mean	Pre-treatment SD	Pre-treatment Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	87.8	0.4	85	86.7	0.6	85	6.8%	1.10 [0.95, 1.25]
Cunali 2011	87	5	29	86	4	29	3.7%	1.00 [-1.33, 3.33]
Deane 2009	87	5	22	84	7	22	2.3%	3.00 [-0.59, 6.59]
Ferguson 1996	83.8	7.3	19	83	7.4	19	1.6%	0.80 [-3.87, 5.47]
Ferguson 1997	75.8	11.6	20	78.7	8.6	20	0.9%	-2.90 [-9.23, 3.43]
Gauthier 2009	95.6	0.3	19	95.2	0.3	19	6.8%	0.40 [0.21, 0.59]
Gauthier 2009	95.4	0.2	19	95.2	0.3	19	6.8%	0.20 [0.04, 0.36]
Gauthier 2011	87.4	1.4	16	83.7	2.1	16	5.5%	3.70 [2.46, 4.94]
Ghazal 2009	86	2.2	48	82	8.2	48	3.6%	4.00 [1.60, 6.40]
Ghazal 2009	85.5	2.2	47	82	9.6	47	3.1%	3.50 [0.68, 6.32]
Gotsopoulos 2002	89	1	73	86	1	73	6.8%	3.00 [2.68, 3.32]
Gotsopoulos 2004	89	1	67	85	6	67	5.2%	4.00 [2.54, 5.46]
Hoekema 2007a	89.8	3.8	20	82	5.2	20	3.1%	7.80 [4.98, 10.62]
Hoekema 2007b	91	7.8	9	78	4.8	9	1.0%	13.00 [7.02, 18.98]
Hoekema 2008a	89.3	4.9	12	77.2	7.8	12	1.3%	12.10 [6.89, 17.31]
Hoekema 2008b	87.7	6.3	47	78	8.5	51	2.9%	9.70 [6.75, 12.65]
Lawton 2005	88	8.1	15	87.5	7.4	15	1.2%	0.50 [-5.05, 6.05]
Lawton 2005	89	7.4	16	87.5	7.4	16	1.3%	1.50 [-3.63, 6.63]
Mehta 2001	91	1	28	87	1	28	6.6%	4.00 [3.48, 4.52]
Naismith 2005	88.7	5.3	73	85.7	5.6	73	4.6%	3.00 [1.23, 4.77]
Phillips 2013	87.2	5.9	126	82.7	7.6	126	4.8%	4.50 [2.82, 6.18]
Randerath 2002	85.3	3.1	20	83.6	4.6	20	3.6%	1.70 [-0.73, 4.13]
Rose 2002	92.2	2.1	20	88.7	1.2	20	5.8%	3.50 [2.44, 4.56]
Rose 2002	90.1	4.8	18	89.1	3.2	18	3.3%	1.00 [-1.67, 3.67]
Vanderveken 2008	82	6	23	83	7	23	2.1%	-1.00 [-4.77, 2.77]
Vanderveken 2008	82	8	23	83	7	23	1.7%	-1.00 [-5.34, 3.34]
Zhou 2012	78.4	5.8	16	75.3	6.9	16	1.7%	3.10 [-1.32, 7.52]
Zhou 2012	89.6	5.6	16	75.3	6.9	16	1.7%	14.30 [9.95, 18.65]
Total (95% CI)			**946**			**950**	**100.0%**	**3.09 [2.43, 3.76]**

Heterogeneity: Tau² = 1.67; Chi² = 622.00, df = 27 (P < 0.00001); I² = 96%
Test for overall effect: Z = 9.13 (P < 0.00001)

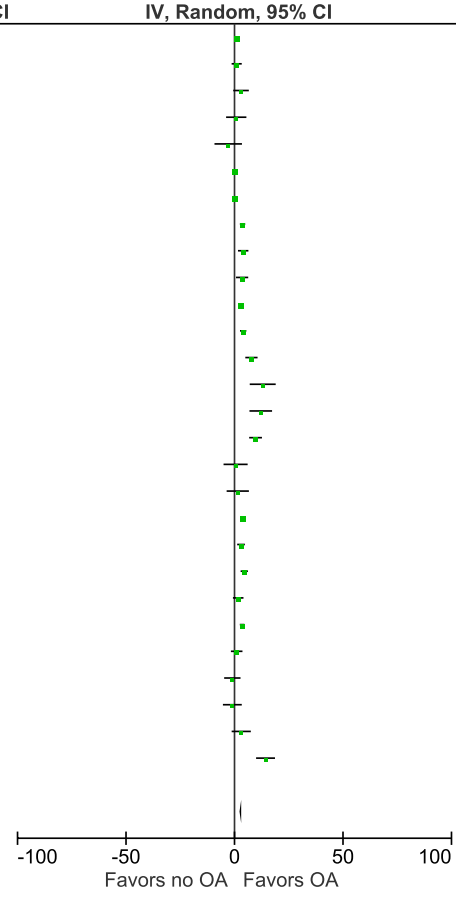

Figure 16—Custom OAs for OSA (Minimum Oxygen Saturation).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	87.8	0.4	85	86.7	0.6	85	7.1%	1.10 [0.95, 1.25]
Cunali 2011	87	5	29	86	4	29	3.9%	1.00 [-1.33, 3.33]
Deane 2009	87	5	22	84	7	22	2.4%	3.00 [-0.59, 6.59]
Ferguson 1997	75.8	11.6	20	78.7	8.6	20	1.0%	-2.90 [-9.23, 3.43]
Gauthier 2009	95.4	0.2	19	95.2	0.3	19	7.1%	0.20 [0.04, 0.36]
Gauthier 2009	95.6	0.3	19	95.2	0.3	19	7.1%	0.40 [0.21, 0.59]
Gauthier 2011	87.4	1.4	16	83.7	2.1	16	5.8%	3.70 [2.46, 4.94]
Ghazal 2009	85.5	2.2	47	82	9.6	47	3.2%	3.50 [0.68, 6.32]
Ghazal 2009	86	2.2	48	82	8.2	48	3.8%	4.00 [1.60, 6.40]
Gotsopoulos 2002	89	1	73	86	1	73	7.0%	3.00 [2.68, 3.32]
Gotsopoulos 2004	89	1	67	85	6	67	5.4%	4.00 [2.54, 5.46]
Hoekema 2007a	89.8	3.8	20	82	5.2	20	3.2%	7.80 [4.98, 10.62]
Hoekema 2007b	91	7.8	9	78	4.8	9	1.1%	13.00 [7.02, 18.98]
Hoekema 2008a	89.3	4.9	12	77.2	7.8	12	1.4%	12.10 [6.89, 17.31]
Hoekema 2008b	87.7	6.3	47	78	8.5	51	3.0%	9.70 [6.75, 12.65]
Lawton 2005	89	7.4	16	87.5	7.4	16	1.4%	1.50 [-3.63, 6.63]
Lawton 2005	88	8.1	15	87.5	7.4	15	1.2%	0.50 [-5.05, 6.05]
Mehta 2001	91	1	28	87	1	28	6.8%	4.00 [3.48, 4.52]
Naismith 2005	88.7	5.3	73	85.7	5.6	73	4.8%	3.00 [1.23, 4.77]
Phillips 2013	87.2	5.9	126	82.7	7.6	126	5.0%	4.50 [2.82, 6.18]
Randerath 2002	85.3	3.1	20	83.6	4.6	20	3.7%	1.70 [-0.73, 4.13]
Rose 2002	92.2	2.1	20	88.7	1.2	20	6.1%	3.50 [2.44, 4.56]
Rose 2002	90.1	4.8	18	89.1	3.2	18	3.4%	1.00 [-1.67, 3.67]
Vanderveken 2008	82	8	23	83	7	23	1.8%	-1.00 [-5.34, 3.34]
Zhou 2012	89.6	5.6	16	75.3	6.9	16	1.8%	14.30 [9.95, 18.65]
Zhou 2012	78.4	5.8	16	75.3	6.9	16	1.8%	3.10 [-1.32, 7.52]
Total (95% CI)			**904**			**908**	**100.0%**	**3.22 [2.54, 3.90]**

Heterogeneity: Tau² = 1.68; Chi² = 620.92, df = 25 (P < 0.00001); I² = 96%
Test for overall effect: Z = 9.32 (P < 0.00001)

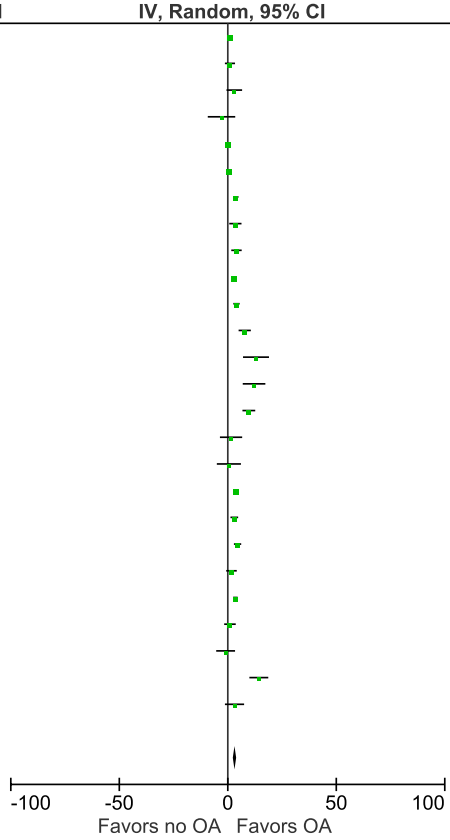

Figure 17—Non-Custom OAs for OSA (Minimum Oxygen Saturation).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ferguson 1996	83.8	7.3	19	83	7.4	19	39.4%	0.80 [-3.87, 5.47]
Vanderveken 2008	82	6	23	83	7	23	60.6%	-1.00 [-4.77, 2.77]
Total (95% CI)			**42**			**42**	**100.0%**	**-0.29 [-3.22, 2.64]**

Heterogeneity: Tau² = 0.00; Chi² = 0.35, df = 1 (P = 0.56); I² = 0%
Test for overall effect: Z = 0.19 (P = 0.85)

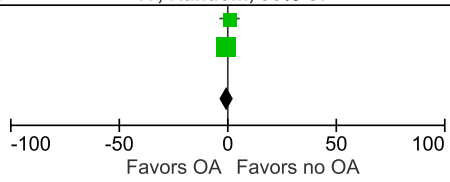

Figure 18—Custom, Titratable OAs for OSA (Minimum Oxygen Saturation).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	87.8	0.4	85	86.7	0.6	85	7.7%	1.10 [0.95, 1.25]
Cunali 2011	87	5	29	86	4	29	4.1%	1.00 [-1.33, 3.33]
Deane 2009	87	5	22	84	7	22	2.5%	3.00 [-0.59, 6.59]
Ferguson 1997	75.8	11.6	20	78.7	8.6	20	1.0%	-2.90 [-9.23, 3.43]
Gauthier 2009	95.4	0.2	19	95.2	0.3	19	7.7%	0.20 [0.04, 0.36]
Gauthier 2009	95.6	0.3	19	95.2	0.3	19	7.7%	0.40 [0.21, 0.59]
Gauthier 2011	87.4	1.4	16	83.7	2.1	16	6.2%	3.70 [2.46, 4.94]
Ghazal 2009	85.5	2.2	47	82	9.6	47	3.4%	3.50 [0.68, 6.32]
Ghazal 2009	86	2.2	48	82	8.2	48	4.0%	4.00 [1.60, 6.40]
Gotsopoulos 2002	89	1	73	86	1	73	7.6%	3.00 [2.68, 3.32]
Gotsopoulos 2004	89	1	67	85	6	67	5.8%	4.00 [2.54, 5.46]
Hoekema 2007a	89.8	3.8	20	82	5.2	20	3.4%	7.80 [4.98, 10.62]
Hoekema 2007b	91	7.8	9	78	4.8	9	1.1%	13.00 [7.02, 18.98]
Hoekema 2008a	89.3	4.9	12	77.2	7.8	12	1.4%	12.10 [6.89, 17.31]
Hoekema 2008b	87.7	6.3	47	78	8.5	51	3.2%	9.70 [6.75, 12.65]
Lawton 2005	88	8.1	15	87.5	7.4	15	1.3%	0.50 [-5.05, 6.05]
Lawton 2005	89	7.4	16	87.5	7.4	16	1.5%	1.50 [-3.63, 6.63]
Mehta 2001	91	1	28	87	1	28	7.4%	4.00 [3.48, 4.52]
Naismith 2005	88.7	5.3	73	85.7	5.6	73	5.1%	3.00 [1.23, 4.77]
Phillips 2013	87.2	5.9	126	82.7	7.6	126	5.3%	4.50 [2.82, 6.18]
Randerath 2002	85.3	3.1	20	83.6	4.6	20	3.9%	1.70 [-0.73, 4.13]
Rose 2002	92.2	2.1	20	88.7	1.2	20	6.6%	3.50 [2.44, 4.56]
Zhou 2012	78.4	5.8	16	75.3	6.9	16	1.9%	3.10 [-1.32, 7.52]
Total (95% CI)			**847**			**851**	**100.0%**	**3.15 [2.46, 3.84]**

Heterogeneity: Tau² = 1.59; Chi² = 584.21, df = 22 (P < 0.00001); I² = 96%
Test for overall effect: Z = 8.97 (P < 0.00001)

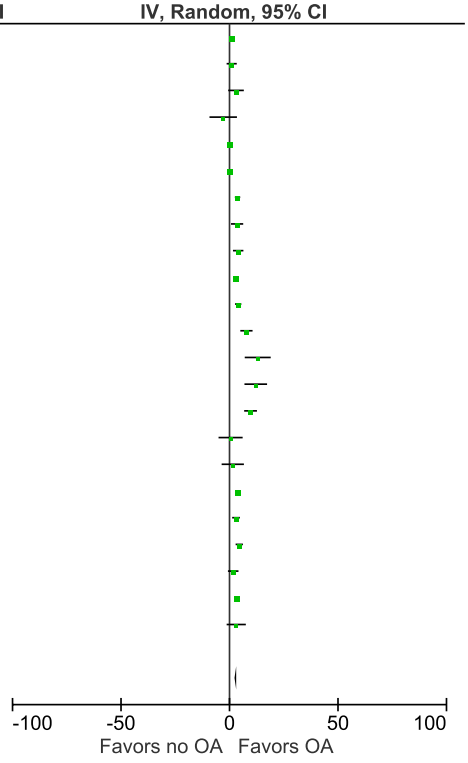

Figure 19—Custom, Non-Titratable OAs for OSA (Minimum Oxygen Saturation).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Rose 2002	90.1	4.8	18	89.1	3.2	18	34.6%	1.00 [-1.67, 3.67]
Vanderveken 2008	82	8	23	83	7	23	32.7%	-1.00 [-5.34, 3.34]
Zhou 2012	89.6	5.6	16	75.3	6.9	16	32.7%	14.30 [9.95, 18.65]
Total (95% CI)			**57**			**57**	**100.0%**	**4.70 [-3.83, 13.22]**

Heterogeneity: Tau² = 52.86; Chi² = 31.13, df = 2 (P < 0.00001); I² = 94%
Test for overall effect: Z = 1.08 (P = 0.28)

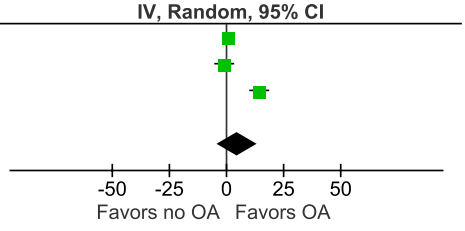

Figure 20—OAs vs. CPAP for OSA (Minimum Oxygen Saturation).

Study or Subgroup	CPAP Mean	SD	Total	OA Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	91.9	0.3	89	87.8	0.4	89	20.0%	4.10 [4.00, 4.20]
Ferguson 1996	88.7	2.5	20	83.8	7.3	19	8.8%	4.90 [1.44, 8.36]
Ferguson 1997	87.7	2.4	20	75.8	11.6	20	5.2%	11.90 [6.71, 17.09]
Hoekema 2007a	88.7	6.5	27	89.8	3.8	20	10.3%	-1.10 [-4.06, 1.86]
Hoekema 2007b	92	4.4	10	91	7.8	10	4.7%	1.00 [-4.55, 6.55]
Hoekema 2008a	89.3	4.2	13	89.3	4.9	13	8.6%	0.00 [-3.51, 3.51]
Hoekema 2008b	89.7	5.8	47	87.7	6.3	47	12.2%	2.00 [-0.45, 4.45]
Phillips 2013	90.6	5	108	87.2	5.9	108	16.3%	3.40 [1.94, 4.86]
Randerath 2002	89	3.4	20	85.3	3.1	20	13.9%	3.70 [1.68, 5.72]
Total (95% CI)			**354**			**346**	**100.0%**	**3.11 [1.74, 4.48]**

Heterogeneity: Tau² = 2.44; Chi² = 30.92, df = 8 (P = 0.0001); I² = 74%
Test for overall effect: Z = 4.45 (P < 0.00001)

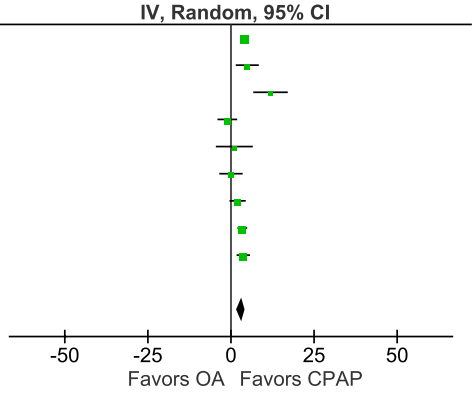

Figure 21—OAs for OSA (Arousal Index).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	4	13.2	20	17	9.6	20	5.0%	-13.00 [-20.15, -5.85]
Aarab 2011b	4.4	14.8	15	17.5	10.4	15	4.1%	-13.10 [-22.25, -3.95]
Barnes 2004	22	1.2	85	23.8	1.2	85	7.5%	-1.80 [-2.16, -1.44]
Blanco 2005	16	11.5	8	33.8	13.9	8	3.0%	-17.80 [-30.30, -5.30]
Bloch 2000	26.5	3.9	24	41	3.7	24	7.1%	-14.50 [-16.65, -12.35]
Bloch 2000	30.9	3.6	24	41	3.7	24	7.2%	-10.10 [-12.17, -8.03]
Deane 2009	21	9	22	33	16	22	4.7%	-12.00 [-19.67, -4.33]
Ghazal 2009	6	3.7	48	18	11.1	48	6.7%	-12.00 [-15.31, -8.69]
Ghazal 2009	9	11.1	47	24	14.1	47	5.9%	-15.00 [-20.13, -9.87]
Gotsopoulos 2002	25	2	73	35	2	73	7.4%	-10.00 [-10.65, -9.35]
Gotsopoulos 2004	25	2	67	33	2	67	7.4%	-8.00 [-8.68, -7.32]
Mehta 2001	27	2	28	41	2	28	7.4%	-14.00 [-15.05, -12.95]
Naismith 2005	25	2	73	35	2	73	7.4%	-10.00 [-10.65, -9.35]
Phillips 2013	19.2	11.6	126	34.3	15.3	126	6.7%	-15.10 [-18.45, -11.75]
Randerath 2002	17	5.1	20	21.8	9.9	20	6.1%	-4.80 [-9.68, 0.08]
Tan 2002	11.6	5.6	24	19.3	9.6	24	6.3%	-7.70 [-12.15, -3.25]
Total (95% CI)			**704**			**704**	**100.0%**	**-10.78 [-13.54, -8.02]**

Heterogeneity: Tau² = 26.57; Chi² = 1207.98, df = 15 (P < 0.00001); I² = 99%
Test for overall effect: Z = 7.65 (P < 0.00001)

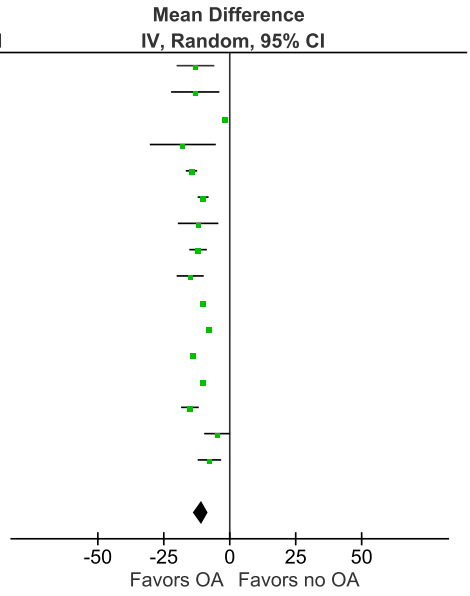

Figure 22—Custom, Titratable OAs for OSA (Arousal Index).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	4	13.2	20	17	9.6	20	5.9%	-13.00 [-20.15, -5.85]
Aarab 2011b	4.4	14.8	15	17.5	10.4	15	4.9%	-13.10 [-22.25, -3.95]
Barnes 2004	22	1.2	85	23.8	1.2	85	8.9%	-1.80 [-2.16, -1.44]
Bloch 2000	30.9	3.6	24	41	3.7	24	8.6%	-10.10 [-12.17, -8.03]
Deane 2009	21	9	22	33	16	22	5.6%	-12.00 [-19.67, -4.33]
Ghazal 2009	9	11.1	47	24	14.1	47	7.1%	-15.00 [-20.13, -9.87]
Ghazal 2009	6	3.7	48	18	11.1	48	8.1%	-12.00 [-15.31, -8.69]
Gotsopoulos 2002	25	2	73	35	2	73	8.9%	-10.00 [-10.65, -9.35]
Gotsopoulos 2004	25	2	67	33	2	67	8.9%	-8.00 [-8.68, -7.32]
Mehta 2001	27	2	28	41	2	28	8.9%	-14.00 [-15.05, -12.95]
Naismith 2005	25	2	73	35	2	73	8.9%	-10.00 [-10.65, -9.35]
Phillips 2013	19.2	11.6	126	34.3	15.3	126	8.0%	-15.10 [-18.45, -11.75]
Randerath 2002	17	5.1	20	21.8	9.9	20	7.2%	-4.80 [-9.68, 0.08]
Total (95% CI)			**648**			**648**	**100.0%**	**-10.44 [-13.44, -7.45]**

Heterogeneity: Tau² = 26.04; Chi² = 1146.17, df = 12 (P < 0.00001); I² = 99%
Test for overall effect: Z = 6.84 (P < 0.00001)

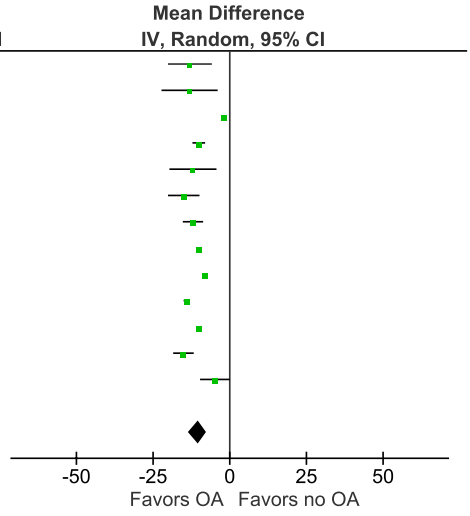

Figure 23—Custom, Non-Titratable OAs for OSA (Arousal Index).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Blanco 2005	16	11.5	8	33.8	13.9	8	2.9%	-17.80 [-30.30, -5.30]
Bloch 2000	26.5	3.9	24	41	3.7	24	97.1%	-14.50 [-16.65, -12.35]
Total (95% CI)			**32**			**32**	**100.0%**	**-14.59 [-16.71, -12.48]**

Heterogeneity: Tau² = 0.00; Chi² = 0.26, df = 1 (P = 0.61); I² = 0%
Test for overall effect: Z = 13.50 (P < 0.00001)

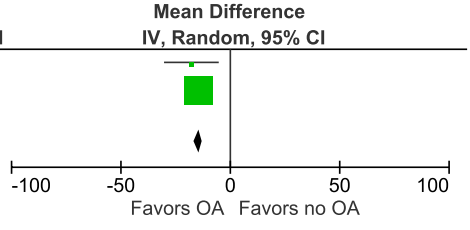

Figure 24—OAs vs. CPAP for OSA (Arousal Index).

Study or Subgroup	OA Mean	OA SD	OA Total	CPAP Mean	CPAP SD	CPAP Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	4	13.2	20	2.5	14.8	18	4.2%	1.50 [-7.46, 10.46]
Aarab 2011b	4.4	14.8	15	1	15.5	13	2.7%	3.40 [-7.87, 14.67]
Barnes 2004	23.8	1.2	85	18.3	0.9	89	37.2%	5.50 [5.18, 5.82]
Phillips 2013	19.2	11.6	110	16.6	10.6	108	20.1%	2.60 [-0.35, 5.55]
Randerath 2002	17	5.1	20	14.1	5.1	20	18.8%	2.90 [-0.26, 6.06]
Tan 2002	11.6	5.6	24	9.8	6.6	24	17.1%	1.80 [-1.66, 5.26]
Total (95% CI)			**274**			**272**	**100.0%**	**3.57 [1.64, 5.51]**

Heterogeneity: Tau² = 2.60; Chi² = 11.25, df = 5 (P = 0.05); I² = 56%
Test for overall effect: Z = 3.61 (P = 0.0003)

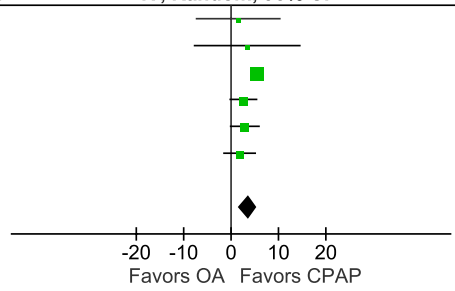

Figure 25—OAs for OSA (Oxygen Desaturation Index; ODI).

Study or Subgroup	Post-treatment Mean	Post-treatment SD	Post-treatment Total	Pre-treatment Mean	Pre-treatment SD	Pre-treatment Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	8.1	1.3	85	12.4	1.5	85	14.7%	-4.30 [-4.72, -3.88]
Ghazal 2009	4	13.5	48	14	10.4	48	12.2%	-10.00 [-14.82, -5.18]
Ghazal 2009	8	8.2	47	16	13.3	47	12.5%	-8.00 [-12.47, -3.53]
Johnston 2002	21.1	19.8	20	30.7	18.8	20	6.5%	-9.60 [-21.57, 2.37]
Phillips 2013	9	11.6	126	20.8	12.5	126	13.6%	-11.80 [-14.78, -8.82]
Wilhelmsson 1999	6.1	1.6	41	17	1.4	41	14.6%	-10.90 [-11.55, -10.25]
Zhou 2012	15	4.8	16	37	6.4	16	12.9%	-22.00 [-25.92, -18.08]
Zhou 2012	12	4.4	16	37	6.4	16	13.0%	-25.00 [-28.81, -21.19]
Total (95% CI)			**399**			**399**	**100.0%**	**-12.77 [-16.85, -8.69]**

Heterogeneity: Tau² = 29.53; Chi² = 445.13, df = 7 (P < 0.00001); I² = 98%
Test for overall effect: Z = 6.13 (P < 0.00001)

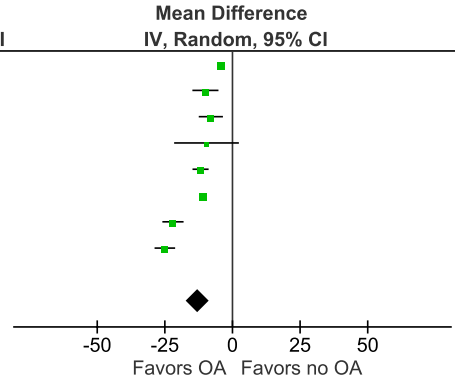

Figure 26—Custom, Titratable OAs for OSA (ODI).

Study or Subgroup	Post-treatment Mean	Post-treatment SD	Post-treatment Total	Pre-treatment Mean	Pre-treatment SD	Pre-treatment Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	8.1	1.3	85	12.4	1.5	85	21.4%	-4.30 [-4.72, -3.88]
Ghazal 2009	7	13.5	48	11.5	10.4	48	19.0%	-4.50 [-9.32, 0.32]
Ghazal 2009	7.2	8.1	47	14.5	13.3	47	19.3%	-7.30 [-11.75, -2.85]
Phillips 2013	9	11.6	126	20.8	12.5	126	20.4%	-11.80 [-14.78, -8.82]
Zhou 2012	15	4.8	16	37	6.4	16	19.8%	-22.00 [-25.92, -18.08]
Total (95% CI)			**322**			**322**	**100.0%**	**-9.95 [-16.25, -3.66]**

Heterogeneity: Tau² = 48.16; Chi² = 101.41, df = 4 (P < 0.00001); I² = 96%
Test for overall effect: Z = 3.10 (P = 0.002)

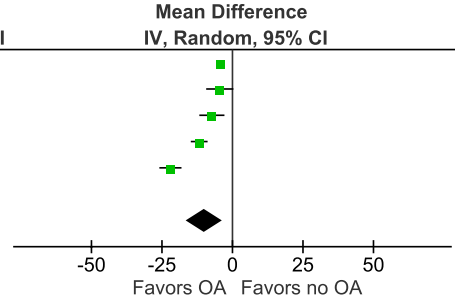

Figure 27—Custom, Non-Titratable OA for OSA (ODI).

Study or Subgroup	Post-treatment Mean	Post-treatment SD	Post-treatment Total	Pre-treatment Mean	Pre-treatment SD	Pre-treatment Total	Weight	Mean Difference IV, Random, 95% CI
Johnston 2002	21.1	19.8	20	30.7	18.8	20	26.4%	-9.60 [-21.57, 2.37]
Wilhelmsson 1999	6.1	3.2	41	17	2.9	41	37.5%	-10.90 [-12.22, -9.58]
Zhou 2012	12	4.4	16	37	6.4	16	36.1%	-25.00 [-28.81, -21.19]
Total (95% CI)			**77**			**77**	**100.0%**	**-15.65 [-26.86, -4.44]**

Heterogeneity: Tau² = 86.83; Chi² = 47.27, df = 2 (P < 0.00001); I² = 96%
Test for overall effect: Z = 2.74 (P = 0.006)

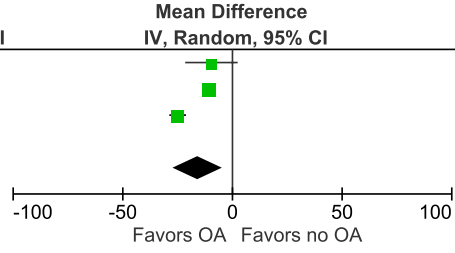

Figure 28—OAs vs. CPAP for OSA (ODI).

Study or Subgroup	OA Mean	OA SD	OA Total	CPAP Mean	CPAP SD	CPAP Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	8.1	1.3	80	1.6	0.2	80	41.5%	6.50 [6.21, 6.79]
Gagnadoux 2009	6.3	5	28	2.3	3.2	28	30.9%	4.00 [1.80, 6.20]
Phillips 2013	9	11.6	126	6	9.7	126	27.7%	3.00 [0.36, 5.64]
Total (95% CI)			**234**			**234**	**100.0%**	**4.76 [2.37, 7.15]**

Heterogeneity: Tau² = 3.57; Chi² = 11.39, df = 2 (P = 0.003); I² = 82%
Test for overall effect: Z = 3.90 (P < 0.0001)

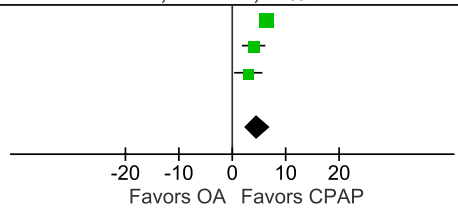

Figure 29—OAs for OSA (% Rapid Eye Movement; %REM).

Study or Subgroup	Post-treatment Mean	Post-treatment SD	Post-treatment Total	Pre-treatment Mean	Pre-treatment SD	Pre-treatment Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	20.2	6.4	20	18.3	6.4	20	3.9%	1.90 [-2.07, 5.87]
Aarab 2011b	22.6	7.6	15	18.6	6.4	21	3.3%	4.00 [-0.72, 8.72]
Barnes 2004	19.8	0.6	80	18.8	0.7	80	7.2%	1.00 [0.80, 1.20]
Blanco 2005	15.5	5.9	8	16.8	4.3	8	3.0%	-1.30 [-6.36, 3.76]
Bloch 2000	15	1	24	14	1	24	7.1%	1.00 [0.43, 1.57]
Bloch 2000	16	1	24	14	1	24	7.1%	2.00 [1.43, 2.57]
Deane 2009	18.2	0.5	22	13.2	0.4	22	7.2%	5.00 [4.73, 5.27]
Ferguson 1996	20	12.3	19	14.3	6.5	19	2.3%	5.70 [-0.56, 11.96]
Ferguson 1997	13.1	6	19	16.1	13.6	19	2.1%	-3.00 [-9.68, 3.68]
Gauthier 2009	22.8	1.2	16	20.2	0.9	16	7.0%	2.60 [1.87, 3.33]
Gauthier 2009	22	1.5	16	20.2	0.9	16	6.9%	1.80 [0.94, 2.66]
Gauthier 2011	18.3	1.8	14	20	1	14	6.8%	-1.70 [-2.78, -0.62]
Ghazal 2009	14	26.4	48	19	29.6	48	0.9%	-5.00 [-16.22, 6.22]
Ghazal 2009	13	4.1	46	14	30.4	46	1.4%	-1.00 [-9.86, 7.86]
Gotsopoulos 2002	18	1	73	18	1	73	7.1%	0.00 [-0.32, 0.32]
Gotsopoulos 2004	18	1	67	18	7	67	6.2%	0.00 [-1.69, 1.69]
Hoekema 2008b	26.5	6.7	47	21	7.8	51	5.0%	5.50 [2.63, 8.37]
Mehta 2001	21	1	24	16	1	24	7.1%	5.00 [4.43, 5.57]
Randerath 2002	14.8	7.3	20	15.1	5.9	20	3.8%	-0.30 [-4.41, 3.81]
Tan 2002	13.8	5.6	24	12.7	5.8	24	4.6%	1.10 [-2.13, 4.33]
Total (95% CI)			**626**			**636**	**100.0%**	**1.67 [0.51, 2.84]**

Heterogeneity: Tau² = 4.89; Chi² = 911.17, df = 19 (P < 0.00001); I² = 98%
Test for overall effect: Z = 2.82 (P = 0.005)

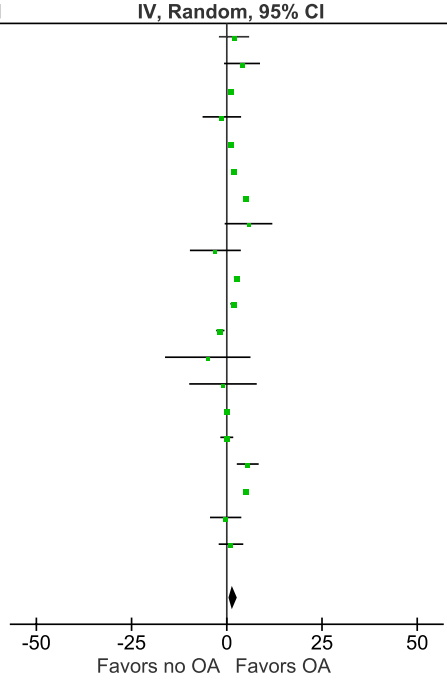

Figure 30—Custom OAs (%REM).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	20.2	6.4	20	18.3	6.4	20	3.3%	1.90 [-2.07, 5.87]
Aarab 2011b	22.6	7.6	15	18.6	6.4	21	2.7%	4.00 [-0.72, 8.72]
Barnes 2004	19.8	0.6	80	18.8	0.7	80	8.0%	1.00 [0.80, 1.20]
Blanco 2005	15.5	5.9	8	16.8	4.3	8	2.4%	-1.30 [-6.36, 3.76]
Bloch 2000	15	1	24	14	1	24	7.8%	1.00 [0.43, 1.57]
Bloch 2000	16	1	24	14	1	24	7.8%	2.00 [1.43, 2.57]
Deane 2009	18.2	0.5	22	14	1	24	7.9%	4.20 [3.75, 4.65]
Ferguson 1997	13.1	6	20	16.1	13.6	20	1.7%	-3.00 [-9.51, 3.51]
Gauthier 2009	22.8	1.2	16	20.2	0.9	16	7.7%	2.60 [1.87, 3.33]
Gauthier 2009	22	1.5	16	20.2	0.9	16	7.5%	1.80 [0.94, 2.66]
Gauthier 2011	18.3	1.8	14	20	1	14	7.3%	-1.70 [-2.78, -0.62]
Ghazal 2009	14	26.4	48	19	29.6	48	0.7%	-5.00 [-16.22, 6.22]
Ghazal 2009	13	4.1	46	14	30.4	46	1.0%	-1.00 [-9.86, 7.86]
Gotsopoulos 2002	18	1	73	18	1	73	8.0%	0.00 [-0.32, 0.32]
Gotsopoulos 2004	18	1	67	18	7	67	6.4%	0.00 [-1.69, 1.69]
Hoekema 2008b	26.5	6.7	47	21	7.8	51	4.6%	5.50 [2.63, 8.37]
Mehta 2001	21	1	24	16	1	24	7.8%	5.00 [4.43, 5.57]
Randerath 2002	14.8	7.3	20	15.1	5.9	20	3.2%	-0.30 [-4.41, 3.81]
Tan 2002	13.8	5.6	24	12.7	5.8	24	4.2%	1.10 [-2.13, 4.33]
Total (95% CI)			**608**			**620**	**100.0%**	**1.58 [0.64, 2.53]**

Heterogeneity: Tau² = 2.91; Chi² = 455.35, df = 18 (P < 0.00001); I² = 96%
Test for overall effect: Z = 3.27 (P = 0.001)

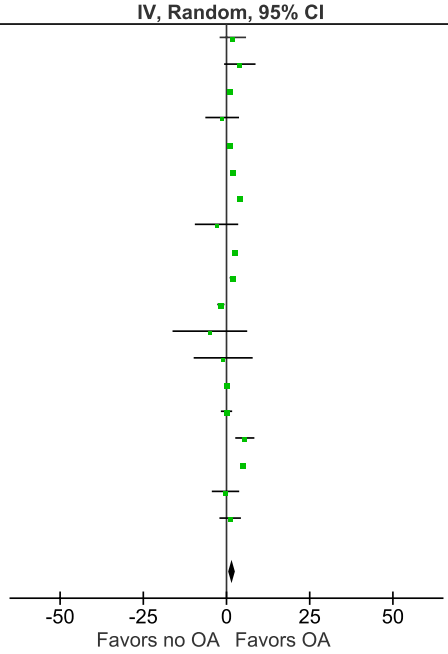

Figure 31—Custom, Titratable OAs for OSA (%REM).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	16.4	6.4	20	18.3	6.4	20	4.8%	-1.90 [-5.87, 2.07]
Aarab 2011b	14.6	7.6	15	18.6	6.4	21	4.1%	-4.00 [-8.72, 0.72]
Barnes 2004	19.8	0.6	80	18.8	0.7	80	8.5%	1.00 [0.80, 1.20]
Bloch 2000	16	1	24	14	1	24	8.4%	2.00 [1.43, 2.57]
Deane 2009	18.2	0.5	22	13.2	0.4	22	8.5%	5.00 [4.73, 5.27]
Ferguson 1997	13.1	6	19	16.1	13.6	19	2.7%	-3.00 [-9.68, 3.68]
Gauthier 2009	22.8	1.2	16	20.2	0.9	16	8.3%	2.60 [1.87, 3.33]
Gauthier 2009	22	1.5	16	20.2	0.9	16	8.3%	1.80 [0.94, 2.66]
Gauthier 2011	18.3	1.8	14	20	1	14	8.1%	-1.70 [-2.78, -0.62]
Ghazal 2009	14	26.4	48	19	29.6	48	1.2%	-5.00 [-16.22, 6.22]
Ghazal 2009	13	4.1	46	14	30.4	46	1.8%	-1.00 [-9.86, 7.86]
Gotsopoulos 2002	18	1	73	18	1	73	8.5%	0.00 [-0.32, 0.32]
Gotsopoulos 2004	18	1	67	18	7	67	7.5%	0.00 [-1.69, 1.69]
Hoekema 2008b	26.5	6.7	47	21	7.8	51	6.1%	5.50 [2.63, 8.37]
Mehta 2001	21	1	24	16	1	24	8.4%	5.00 [4.43, 5.57]
Randerath 2002	14.8	7.3	20	15.1	5.9	20	4.7%	-0.30 [-4.41, 3.81]
Total (95% CI)			**551**			**561**	**100.0%**	**1.24 [-0.09, 2.56]**

Heterogeneity: Tau² = 5.32; Chi² = 904.08, df = 15 (P < 0.00001); I² = 98%
Test for overall effect: Z = 1.83 (P = 0.07)

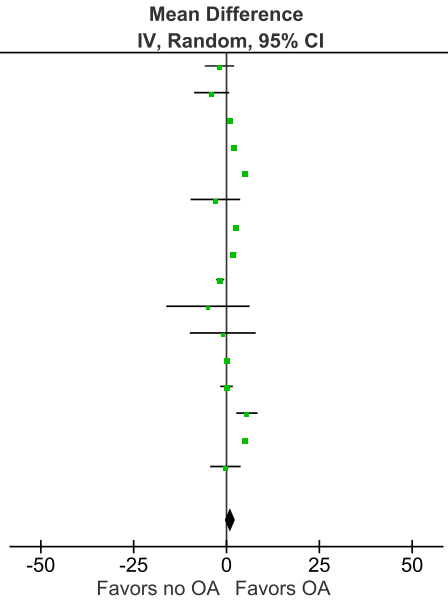

Figure 32—Custom, Non-Titratable OA for OSA (%REM).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Blanco 2005	15.5	5.9	8	16.8	4.3	8	1.2%	-1.30 [-6.36, 3.76]
Bloch 2000	15	1	24	14	1	24	98.8%	1.00 [0.43, 1.57]
Total (95% CI)			**32**			**32**	**100.0%**	**0.97 [0.41, 1.53]**

Heterogeneity: Tau² = 0.00; Chi² = 0.78, df = 1 (P = 0.38); I² = 0%
Test for overall effect: Z = 3.39 (P = 0.0007)

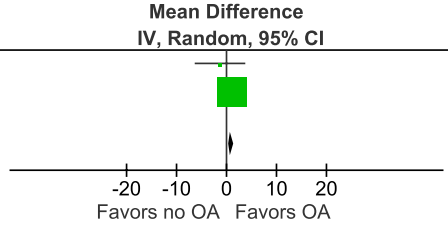

Figure 33—OAs vs. CPAP for OSA (%REM).

Study or Subgroup	CPAP Mean	CPAP SD	CPAP Total	OA Mean	OA SD	OA Total	Weight	Mean Difference IV, Random, 95% CI
Aarab 2011a	20.6	10.4	20	16.4	6.4	20	7.7%	4.20 [-1.15, 9.55]
Aarab 2011b	19.3	10.6	13	14.6	7.6	15	5.3%	4.70 [-2.23, 11.63]
Barnes 2004	18.9	0.5	80	19.8	0.6	80	23.9%	-0.90 [-1.07, -0.73]
Ferguson 1996	16.1	6.1	20	14.3	6.5	19	11.1%	1.80 [-2.16, 5.76]
Ferguson 1997	12.1	5.4	20	13.1	6	19	12.3%	-1.00 [-4.59, 2.59]
Hoekema 2008b	24.1	5.7	47	26.5	6.7	47	16.4%	-2.40 [-4.91, 0.11]
Randerath 2002	15.3	6.8	20	14.8	7.3	20	10.0%	0.50 [-3.87, 4.87]
Tan 2002	18.5	6.1	24	13.8	5.6	24	13.3%	4.70 [1.39, 8.01]
Total (95% CI)			**244**			**244**	**100.0%**	**0.72 [-1.09, 2.52]**

Heterogeneity: Tau² = 3.54; Chi² = 20.45, df = 7 (P = 0.005); I² = 66%
Test for overall effect: Z = 0.78 (P = 0.44)

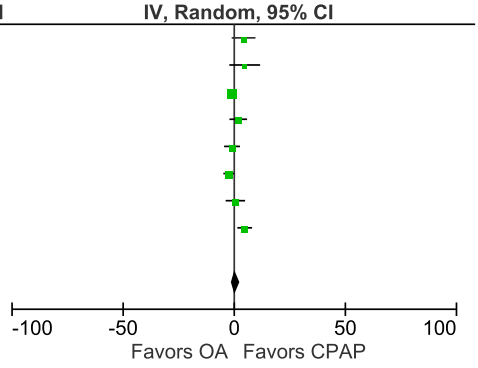

Figure 34—OAs for OSA (Sleep Efficiency).

Study or Subgroup	Post-treatment Mean	Post-treatment SD	Post-treatment Total	Pre-treatment Mean	Pre-treatment SD	Pre-treatment Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	82	1	80	79.5	1.1	80	7.8%	2.50 [2.17, 2.83]
Blanco 2005	71.3	12	8	65.8	15.2	8	0.7%	5.50 [-7.92, 18.92]
Bloch 2000	88	2	24	89	2	24	7.3%	-1.00 [-2.13, 0.13]
Bloch 2000	89	1	24	89	2	24	7.5%	0.00 [-0.89, 0.89]
Deane 2009	78	17	22	80	11	22	1.5%	-2.00 [-10.46, 6.46]
Ferguson 1996	86.5	10.6	19	88	5.4	19	3.0%	-1.50 [-6.85, 3.85]
Ferguson 1997	87.9	5.5	19	85.9	5.7	19	4.5%	2.00 [-1.56, 5.56]
Gauthier 2009	85.6	2.1	16	83.1	2	16	7.0%	2.50 [1.08, 3.92]
Gauthier 2009	83.9	2.1	16	83.1	2	16	7.0%	0.80 [-0.62, 2.22]
Gauthier 2011	80.9	2.1	14	83.6	2.2	14	6.9%	-2.70 [-4.29, -1.11]
Ghazal 2009	89	14.1	48	81	14.1	48	2.8%	8.00 [2.36, 13.64]
Ghazal 2009	82	11.8	47	89	16.8	47	2.6%	-7.00 [-12.87, -1.13]
Gotsopoulos 2002	84	1	73	81	1	73	7.8%	3.00 [2.68, 3.32]
Gotsopoulos 2004	83	1	61	80	12	61	5.1%	3.00 [-0.02, 6.02]
Hoekema 2008b	86.1	8.1	47	88.3	9.7	51	4.6%	-2.20 [-5.73, 1.33]
Mehta 2001	85	1	24	87	1	24	7.7%	-2.00 [-2.57, -1.43]
Naismith 2005	83.6	10.7	73	80.6	12	73	4.4%	3.00 [-0.69, 6.69]
Tan 2002	83.2	8.1	24	81.6	10.4	24	3.0%	1.60 [-3.67, 6.87]
Vanderveken 2008	81	12	23	78	11	23	2.2%	3.00 [-3.65, 9.65]
Vanderveken 2008	80	11	23	78	11	23	2.4%	2.00 [-4.36, 8.36]
Zhou 2012	84.9	7.8	16	80.7	12.5	16	2.0%	4.20 [-3.02, 11.42]
Zhou 2012	89.4	6.4	16	80.7	12.5	16	2.1%	8.70 [1.82, 15.58]
Total (95% CI)			**717**			**721**	**100.0%**	**0.95 [-0.21, 2.12]**

Heterogeneity: Tau² = 4.48; Chi² = 342.31, df = 21 (P < 0.00001); I² = 94%
Test for overall effect: Z = 1.60 (P = 0.11)

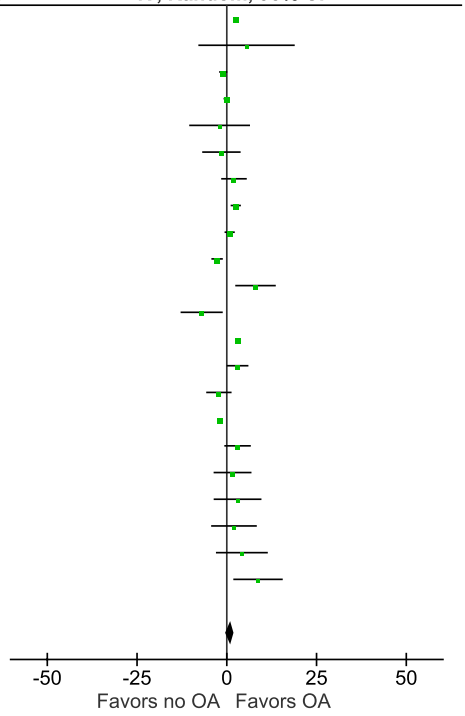

Figure 35—Custom OAs for OSA (Sleep Efficiency).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	82	1	80	79.5	1.1	80	8.2%	2.50 [2.17, 2.83]
Blanco 2005	71.3	12	8	65.8	15.2	8	0.7%	5.50 [-7.92, 18.92]
Bloch 2000	88	2	24	89	2	24	7.7%	-1.00 [-2.13, 0.13]
Bloch 2000	89	1	24	89	2	24	7.9%	0.00 [-0.89, 0.89]
Deane 2009	78	17	22	80	11	22	1.6%	-2.00 [-10.46, 6.46]
Ferguson 1997	87.9	5.5	19	85.9	5.7	19	4.8%	2.00 [-1.56, 5.56]
Gauthier 2009	85.6	2.1	16	83.1	2	16	7.4%	2.50 [1.08, 3.92]
Gauthier 2009	83.9	2.1	16	83.1	2	16	7.4%	0.80 [-0.62, 2.22]
Gauthier 2011	80.9	2.1	14	83.6	2.2	14	7.2%	-2.70 [-4.29, -1.11]
Ghazal 2009	82	11.8	47	89	16.8	47	2.8%	-7.00 [-12.87, -1.13]
Ghazal 2009	89	14.1	48	81	14.1	48	2.9%	8.00 [2.36, 13.64]
Gotsopoulos 2002	84	1	73	81	1	73	8.2%	3.00 [2.68, 3.32]
Gotsopoulos 2004	83	1	61	80	12	61	5.4%	3.00 [-0.02, 6.02]
Hoekema 2008b	86.1	8.1	47	88.3	9.7	51	4.8%	-2.20 [-5.73, 1.33]
Mehta 2001	85	1	24	87	1	24	8.1%	-2.00 [-2.57, -1.43]
Naismith 2005	83.6	10.7	73	80.6	12	73	4.6%	3.00 [-0.69, 6.69]
Tan 2002	83.2	8.1	24	81.6	10.4	24	3.2%	1.60 [-3.67, 6.87]
Vanderveken 2008	80	11	23	78	11	23	2.5%	2.00 [-4.36, 8.36]
Zhou 2012	84.9	7.8	16	80.7	12.5	16	2.1%	4.20 [-3.02, 11.42]
Zhou 2012	89.4	6.4	16	80.7	12.5	16	2.2%	8.70 [1.82, 15.58]
Total (95% CI)			**675**			**679**	**100.0%**	**0.98 [-0.22, 2.18]**

Heterogeneity: Tau² = 4.50; Chi² = 340.73, df = 19 (P < 0.00001); I² = 94%
Test for overall effect: Z = 1.61 (P = 0.11)

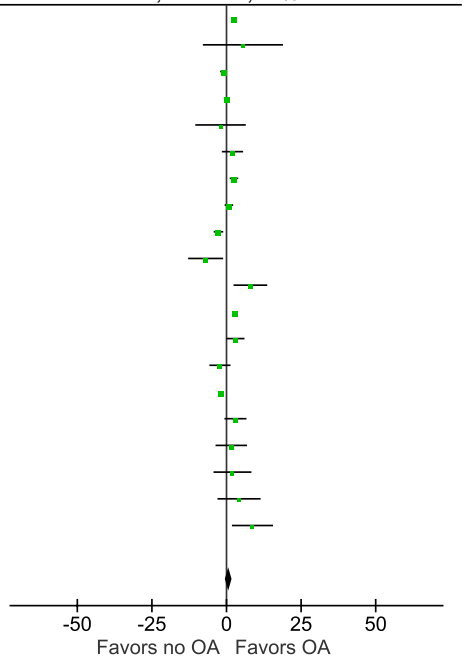

Figure 36—Non-Custom OAs for OSA (Sleep Efficiency).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ferguson 1996	86.5	10.6	19	88	5.4	19	60.1%	-1.50 [-6.85, 3.85]
Vanderveken 2008	81	12	23	78	11	23	39.9%	3.00 [-3.65, 9.65]
Total (95% CI)			**42**			**42**	**100.0%**	**0.30 [-4.02, 4.62]**

Heterogeneity: Tau² = 0.64; Chi² = 1.07, df = 1 (P = 0.30); I² = 6%
Test for overall effect: Z = 0.13 (P = 0.89)

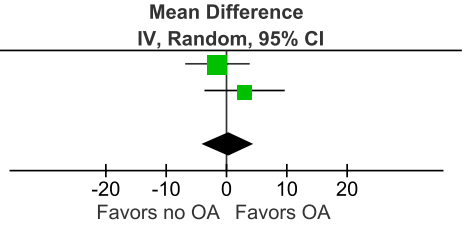

Figure 37—Custom, Titratable OA for OSA (Sleep Efficiency).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	82	1	80	79.5	1.1	80	9.9%	2.50 [2.17, 2.83]
Bloch 2000	89	1	24	89	2	24	9.5%	0.00 [-0.89, 0.89]
Deane 2009	78	17	22	80	11	22	1.9%	-2.00 [-10.46, 6.46]
Ferguson 1997	87.9	5.5	19	85.9	5.7	19	5.7%	2.00 [-1.56, 5.56]
Gauthier 2009	83.9	2.1	16	83.1	2	16	8.9%	0.80 [-0.62, 2.22]
Gauthier 2009	85.6	2.1	16	83.1	2	16	8.9%	2.50 [1.08, 3.92]
Gauthier 2011	80.9	2.1	14	83.6	2.2	14	8.7%	-2.70 [-4.29, -1.11]
Ghazal 2009	89	14.1	48	81	14.1	48	3.5%	8.00 [2.36, 13.64]
Ghazal 2009	82	11.8	47	89	16.8	47	3.3%	-7.00 [-12.87, -1.13]
Gotsopoulos 2002	84	1	73	81	1	73	9.9%	3.00 [2.68, 3.32]
Gotsopoulos 2004	83	1	61	80	12	61	6.5%	3.00 [-0.02, 6.02]
Hoekema 2008b	86.1	8.1	47	88.3	9.7	51	5.7%	-2.20 [-5.73, 1.33]
Mehta 2001	85	1	24	87	1	24	9.8%	-2.00 [-2.57, -1.43]
Naismith 2005	83.6	10.7	73	80.6	12	73	5.5%	3.00 [-0.69, 6.69]
Zhou 2012	84.9	7.8	16	80.7	12.5	16	2.4%	4.20 [-3.02, 11.42]
Total (95% CI)			**580**			**584**	**100.0%**	**0.87 [-0.43, 2.17]**

Heterogeneity: Tau² = 4.44; Chi² = 312.55, df = 14 (P < 0.00001); I² = 96%
Test for overall effect: Z = 1.31 (P = 0.19)

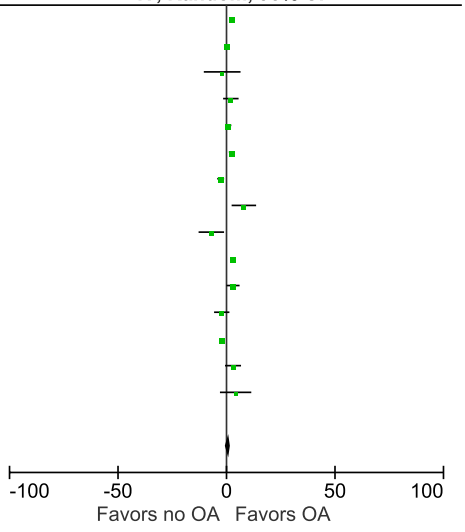

Figure 38—Custom, Non-Titratable OA for OSA (Sleep Efficiency).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Blanco 2005	71.3	12	8	65.8	15.2	8	10.5%	5.50 [-7.92, 18.92]
Bloch 2000	88	2	24	89	2	24	41.0%	-1.00 [-2.13, 0.13]
Vanderveken 2008	80	11	23	78	11	23	25.1%	2.00 [-4.36, 8.36]
Zhou 2012	89.4	6.4	16	80.7	12.5	16	23.4%	8.70 [1.82, 15.58]
Total (95% CI)			**71**			**71**	**100.0%**	**2.71 [-2.32, 7.73]**

Heterogeneity: Tau² = 15.70; Chi² = 8.93, df = 3 (P = 0.03); I² = 66%
Test for overall effect: Z = 1.06 (P = 0.29)

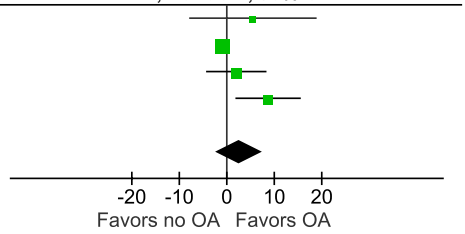

Figure 39—OAs vs. CPAP (Sleep Efficiency).

Study or Subgroup	CPAP Mean	SD	Total	OA Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	82.1	0.8	80	82	1	80	80.0%	0.10 [-0.18, 0.38]
Ferguson 1996	87.8	7.7	20	88	5.4	19	3.9%	-0.20 [-4.36, 3.96]
Ferguson 1997	89.9	3.4	20	87.9	5.5	20	8.0%	2.00 [-0.83, 4.83]
Hoekema 2008b	86.2	10	47	86.1	8.1	47	4.9%	0.10 [-3.58, 3.78]
Tan 2002	87.2	8.1	24	83.2	8.1	24	3.2%	4.00 [-0.58, 8.58]
Total (95% CI)			**191**			**190**	**100.0%**	**0.37 [-0.47, 1.21]**

Heterogeneity: Tau² = 0.21; Chi² = 4.48, df = 4 (P = 0.34); I² = 11%
Test for overall effect: Z = 0.85 (P = 0.39)

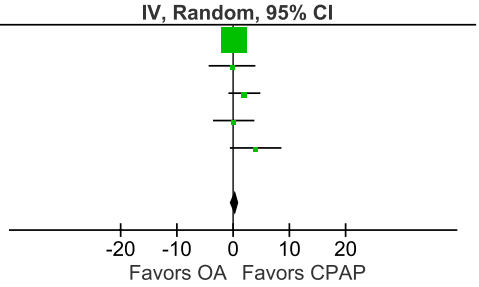

Figure 40—Summary of Findings: OA Pre- vs. Post-Treatment of OSA (All Physiologic Sleep Outcome Measures).

OAs for OSA

Patient or population: Patients with OSA
Intervention: OAs

Outcomes	Illustrative comparative risks* (95% CI) Assumed risk	Corresponding risk	Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Control	**OAs**				
AHI/RDI/REI		The mean AHI/RDI in the intervention groups was **13.59 lower** (15.25 to 11.94 lower)		1301 (34 studies)	⊕⊕⊕⊖ **moderate**[1]	
Minimum Oxygen Saturation		The mean min oxygen saturation in the intervention groups was **3.09 higher** (2.43 to 3.76 higher)		946 (22 studies)	⊕⊕⊕⊖ **moderate**[1]	
Arousal Index		The mean arousal index in the intervention groups was **10.78 lower** (13.54 to 8.02 lower)		704 (14 studies)	⊕⊕⊕⊖ **moderate**[1]	
ODI		The mean ODI in the intervention groups was **12.77 lower** (16.85 to 8.69 lower)		399 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	
%REM		The mean %REM in the intervention groups was **1.67 higher** (0.51 to 0 higher)		626 (17 studies)	⊕⊕⊖⊖ **low**[1,2]	
Sleep Efficiency		The mean sleep efficiency in the intervention groups was **0.95 higher** (0.21 lower to 2.12 higher)		717 (17 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 41—Summary of Findings: Custom OAs Pre- vs. Post-Treatment of OSA (All Physiologic Sleep Outcome Measures).

Custom OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom OAs**				
AHI/RDI/REI		The mean AHI/RDI in the intervention groups was **13.89 lower** (15.57 to 12.20 lower)		1259 (33 studies)	⊕⊕⊕⊖ **moderate**[1]	
Minimum Oxygen Saturation		The mean min oxygen sat. in the intervention groups was **3.22 higher** (2.54 to 3.90 higher)		904 (21 studies)	⊕⊕⊕⊖ **moderate**[1]	
Arousal Index		The mean arousal index in the intervention groups was **10.78 lower** (13.54 to 8.02 lower)		704 (14 studies)	⊕⊕⊕⊖ **moderate**[1]	
ODI		The mean ODI in the intervention groups was **12.77 lower** (16.85 to 8.69 lower)		399 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	
%REM		The mean %REM in the intervention groups was **1.58 higher** (0.64 to 2.53 higher)		608 (16 studies)	⊕⊕⊖⊖ **low**[1,2]	
Sleep Efficiency		The mean sleep efficiency in the intervention groups was **0.95 higher** (0.22 lower to 2.18 higher)		675 (16 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI crosses the decision making threshold

Figure 42—Summary of Findings: Non-Custom OAs Pre- vs. Post-Treatment of OSA (All Physiologic Sleep Outcome Measures).

Non-Custom OAs for OSA

Patient or population: Patients with OSA
Intervention: Non-Custom OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Non-Custom OAs**				
AHI/RDI/REI		The mean AHI/RDI in the intervention groups was **6.28 lower** (13.13 to 0.56 lower)		42 (2 studies)	⊕⊕⊖⊖ **low**[1,2]	
Minimum Oxygen Saturation		The mean min oxygen sat. in the intervention groups was **0.29 lower** (3.22 lower to 2.64 higher)		42 (2 studies)	⊕⊕⊕⊖ **moderate**[2]	
Arousal Index				(0 studies)	N/A	
ODI				(0 studies)	N/A	
%REM		The mean %REM in the intervention groups was **5.70 higher** (0.56 lower to 11.96 higher)		19 (1 study)	⊕⊕⊕⊖ **moderate**[2]	
Sleep Efficiency		The mean sleep efficiency in the intervention groups was **0.3 higher** (4.02 lower to 4.62 higher)		42 (2 studies)	⊕⊕⊕⊖ **moderate**[2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 43—Summary of Findings: Custom, Titratable OAs Pre- vs. Post-Treatment of OSA (All Physiologic Sleep Outcome Measures).

Custom, titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Custom, titratable OAs				
AHI/RDI/REI		The mean AHI/RDI in the intervention groups was **13.80 lower** (15.74 to 11.87 lower)		1054 (27 studies)	⊕⊕⊕⊖ **moderate**[1]	
Minimum Oxygen Saturation		The mean oxygen saturation in the intervention groups was **3.15 higher** (2.46 to 3.84 higher)		847 (20 studies)	⊕⊕⊕⊖ **moderate**[1,2]	
Arousal Index		The mean arousal index in the intervention groups was **10.44 lower** (13.44 to 7.45 lower)		648 (12 studies)	⊕⊕⊕⊖ **moderate**[1]	
ODI		The mean ODI in the intervention groups was **9.95 lower** (16.25 to 3.66 lower)		322 (4 studies)	⊕⊕⊕⊖ **moderate**[1]	
%REM		The mean %REM in the intervention groups was **1.24 higher** (0.09 to 2.56 higher)		551 (14 studies)	⊕⊕⊖⊖ **low**[1,2]	
Sleep Efficiency		The mean sleep efficiency in the intervention groups was **0.87 higher** (0.43 lower to 2.17 higher)		580 (13 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 44—Summary of Findings: Custom, Non-Titratable OAs Pre- vs. Post-Treatment of OSA (All Physiologic Sleep Outcome Measures).

Custom, non-titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, non-titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Custom, non-titratable OAs				
AHI/RDI/REI		The mean AHI in the intervention groups was **12.51 lower** (15.23 to 9.8 lower)		164 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	
Minimum Oxygen Saturation		The mean min oxygen sat. in the intervention groups was **4.70 higher** (3.83 to 13.22 higher)		57 (3 studies)	⊕⊕⊖⊖ **low**[1,2]	
Arousal Index		The mean arousal index in the intervention groups was **14.59 lower** (12.48 to 16.71 lower)		272 (2 studies)	⊕⊕⊖⊖ **low**[1,2]	
ODI		The mean ODI in the intervention groups was **15.65 lower** (28.86 to 4.44 lower)		77 (3 studies)	⊕⊕⊕⊖ **moderate**[1]	
%REM		The mean %REM in the intervention groups was **0.97 lower** (0.41 to 1.53 lower)		32 (2 studies)	⊕⊕⊕⊖ **moderate**[2]	
Sleep Efficiency		The mean sleep efficiency in the intervention groups was **2.71 higher** (2.32 lower to 7.73 higher)		71 (4 studies)	⊕⊕⊕⊖ **moderate**[2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses the clinical decision threshold

Figure 45—Summary of Findings: OAs vs. CPAP for OSA (All Physiologic Sleep Outcome Measures).

OAs compared to CPAP for OSA

Patient or population: patients with OSA
Intervention: OAs
Comparison: CPAP

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	CPAP	OAs				
AHI/RDI/REI		The mean AHI/RDI in the intervention groups was **6.24 higher** (8.14 to 4.34 higher)		481 (15 studies)	⊕⊕⊕⊖ **moderate**[1]	
Oxygen Saturation		The mean oxygen saturation in the intervention groups was **3.11 lower** (1.74 to 4.48 lower)		354 (9 studies)	⊕⊕⊕⊖ **moderate**[1]	
Arousal Index		The mean arousal index in the intervention groups was **3.57 higher** (5.51 to 1.64 higher)		274 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	
Sleep Efficiency		The mean sleep efficiency in the intervention groups was **0.37 lower** (0.47 higher to 1.21 lower)		191 (5 studies)	⊕⊕⊕⊖ **moderate**[2]	
%REM		The mean %REM in the intervention groups was **0.72 lower** (1.09 higher to 2.52 lower)		244 (8 studies)	⊕⊕⊖⊖ **low**[1,2]	
ODI		The mean ODI in the intervention groups was **4.76 higher** (7.15 to 2.37 higher)		234 (3 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 46—OAs for OSA (Epworth Sleepiness Scale; ESS).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Andren 2012	6.7	5.4	36	11	5.4	36	2.9%	-4.30 [-6.79, -1.81]
Barnes 2004	9.2	0.4	85	10.7	0.4	85	6.2%	-1.50 [-1.62, -1.38]
Blanco 2005	5.1	1.9	8	14.7	5.1	8	1.7%	-9.60 [-13.37, -5.83]
Bloch 2000	8.6	2.6	24	13.1	4.8	24	3.3%	-4.50 [-6.68, -2.32]
Bloch 2000	8.9	3.3	24	13.1	4.8	24	3.1%	-4.20 [-6.53, -1.87]
Campbell 2009	9.5	5.1	12	11	5.3	12	1.5%	-1.50 [-5.66, 2.66]
Campbell 2009	7.8	4.5	16	11	5.3	16	2.0%	-3.20 [-6.61, 0.21]
Cunali 2011	11	6	14	12	6	14	1.3%	-1.00 [-5.44, 3.44]
Engleman 2002	12	5	19	13	4	19	2.5%	-1.00 [-3.88, 1.88]
Gagnadoux 2009	7.7	4	59	10.6	4.5	59	4.3%	-2.90 [-4.44, -1.36]
Gauthier 2009	9.9	1.3	16	13.9	1.3	16	5.4%	-4.00 [-4.90, -3.10]
Gauthier 2009	9.3	1.2	16	13.9	1.3	16	5.4%	-4.60 [-5.47, -3.73]
Gauthier 2011	7.7	1	14	13.5	1.5	14	5.3%	-5.80 [-6.74, -4.86]
Ghazal 2009	6.5	5.9	47	7.5	7.4	47	2.6%	-1.00 [-3.71, 1.71]
Ghazal 2009	4.5	3	48	10	5.9	48	3.8%	-5.50 [-7.37, -3.63]
Gotsopoulos 2002	7	1	73	11	5	73	4.9%	-4.00 [-5.17, -2.83]
Hoekema 2007a	5	4.1	20	11	8.2	20	1.6%	-6.00 [-10.02, -1.98]
Hoekema 2007b	6.7	6	9	11.3	7.9	9	0.7%	-4.60 [-11.08, 1.88]
Hoekema 2008a	4.5	5.4	12	12.5	5.9	12	1.3%	-8.00 [-12.53, -3.47]
Hoekema 2008b	6.9	5.5	51	12.9	5.6	51	3.3%	-6.00 [-8.15, -3.85]
Johnston 2002	11.6	6.7	18	13.9	6.4	18	1.4%	-2.30 [-6.58, 1.98]
Lawton 2005	8.5	10.4	15	10	11.8	15	0.5%	-1.50 [-9.46, 6.46]
Lawton 2005	8	10.4	16	10	11.8	16	0.5%	-2.00 [-9.71, 5.71]
Mehta 2001	3.9	0.6	24	10.1	1.1	24	5.9%	-6.20 [-6.70, -5.70]
Naismith 2005	7.1	4.5	73	10.9	4.8	73	4.4%	-3.80 [-5.31, -2.29]
Phillips 2013	7.2	0.4	108	9.1	0.4	108	6.2%	-1.90 [-2.01, -1.79]
Tan 2002	9	5.1	24	13.4	4.6	24	2.6%	-4.40 [-7.15, -1.65]
Tzepizur 2009	8.2	3.7	12	11	4.4	12	2.1%	-2.80 [-6.05, 0.45]
Vanderveken 2008	6	4	23	7	5	23	2.7%	-1.00 [-3.62, 1.62]
Vanderveken 2008	5	4	23	7	5	23	2.7%	-2.00 [-4.62, 0.62]
Zhou 2012	8	2.5	16	11.88	2.68	16	3.9%	-3.88 [-5.68, -2.08]
Zhou 2012	7.88	2.3	16	11.88	2.68	16	4.0%	-4.00 [-5.73, -2.27]
Total (95% CI)			**971**			**971**	**100.0%**	**-3.81 [-4.39, -3.23]**

Heterogeneity: Tau² = 1.42; Chi² = 551.58, df = 31 (P < 0.00001); I² = 94%
Test for overall effect: Z = 12.84 (P < 0.00001)

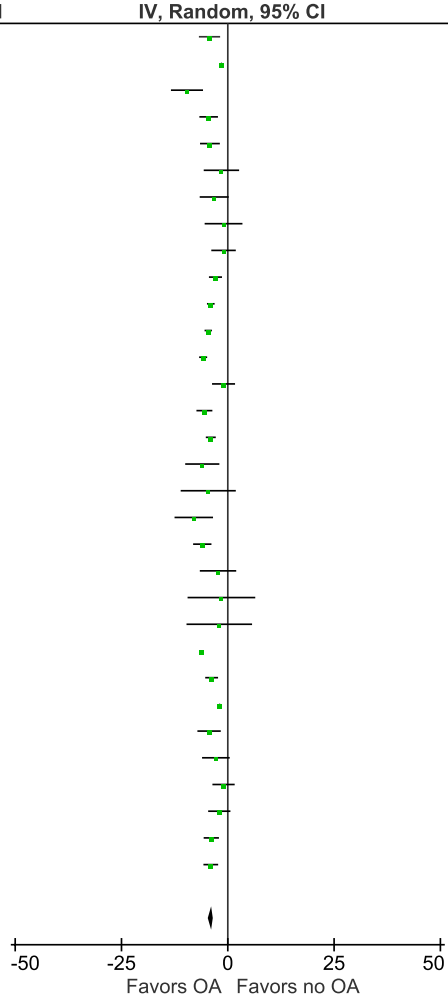

Figure 47—Custom OAs for OSA (ESS).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Andren 2012	6.7	5.4	36	11	5.4	36	0.1%	-4.30 [-6.79, -1.81]
Barnes 2004	9.2	0.4	85	10.7	0.4	85	40.9%	-1.50 [-1.62, -1.38]
Blanco 2005	5.1	1.9	8	14.7	5.1	8	0.0%	-9.60 [-13.37, -5.83]
Bloch 2000	8.9	3.3	24	13.1	4.8	24	0.1%	-4.20 [-6.53, -1.87]
Bloch 2000	8.6	2.6	24	13.1	4.8	24	0.1%	-4.50 [-6.68, -2.32]
Campbell 2009	9.5	5.1	12	11	5.3	12	0.0%	-1.50 [-5.66, 2.66]
Campbell 2009	7.8	4.5	16	11	5.3	16	0.1%	-3.20 [-6.61, 0.21]
Cunali 2011	11	6	14	12	6	14	0.0%	-1.00 [-5.44, 3.44]
Engleman 2002	12	5	19	13	4	19	0.1%	-1.00 [-3.88, 1.88]
Gagnadoux 2009	7.7	4	59	10.6	4.5	59	0.3%	-2.90 [-4.44, -1.36]
Gauthier 2009	9.9	1.3	16	13.9	1.3	16	0.7%	-4.00 [-4.90, -3.10]
Gauthier 2009	9.3	1.2	16	13.9	1.3	16	0.8%	-4.60 [-5.47, -3.73]
Gauthier 2011	7.7	1	14	13.5	1.5	14	0.7%	-5.80 [-6.74, -4.86]
Ghazal 2009	6.5	5.9	47	7.5	7.4	47	0.1%	-1.00 [-3.71, 1.71]
Ghazal 2009	4.5	3	48	10	5.9	48	0.2%	-5.50 [-7.37, -3.63]
Gotsopoulos 2002	7	1	73	11	5	73	0.4%	-4.00 [-5.17, -2.83]
Hoekema 2007a	5	4.1	20	11	8.2	20	0.0%	-6.00 [-10.02, -1.98]
Hoekema 2007b	6.7	6	9	11.3	7.9	9	0.0%	-4.60 [-11.08, 1.88]
Hoekema 2008a	4.5	5.4	12	12.5	5.9	12	0.0%	-8.00 [-12.53, -3.47]
Hoekema 2008b	6.9	5.5	51	12.9	5.6	51	0.1%	-6.00 [-8.15, -3.85]
Johnston 2002	11.6	6.7	18	13.9	6.4	18	0.0%	-2.30 [-6.58, 1.98]
Lawton 2005	8.5	10.4	15	10	11.8	15	0.0%	-1.50 [-9.46, 6.46]
Lawton 2005	8	10.4	16	10	11.8	16	0.0%	-2.00 [-9.71, 5.71]
Mehta 2001	3.9	0.6	24	10.1	1.1	24	2.4%	-6.20 [-6.70, -5.70]
Naismith 2005	7.1	4.5	73	10.9	4.8	73	0.3%	-3.80 [-5.31, -2.29]
Phillips 2013	7.2	0.4	108	9.1	0.4	108	52.0%	-1.90 [-2.01, -1.79]
Tan 2002	9	5.1	24	13.4	4.6	24	0.1%	-4.40 [-7.15, -1.65]
Tzepizur 2009	8.2	3.7	12	11	4.4	12	0.1%	-2.80 [-6.05, 0.45]
Vanderveken 2008	5	4	23	7	5	23	0.1%	-2.00 [-4.62, 0.62]
Zhou 2012	7.88	2.3	16	11.88	2.68	16	0.2%	-4.00 [-5.73, -2.27]
Zhou 2012	8	2.5	16	11.88	2.68	16	0.2%	-3.88 [-5.68, -2.08]
Total (95% CI)			**948**			**948**	**100.0%**	**-1.95 [-2.03, -1.88]**

Heterogeneity: Chi² = 551.07, df = 30 (P < 0.00001); I² = 95%
Test for overall effect: Z = 49.75 (P < 0.00001)

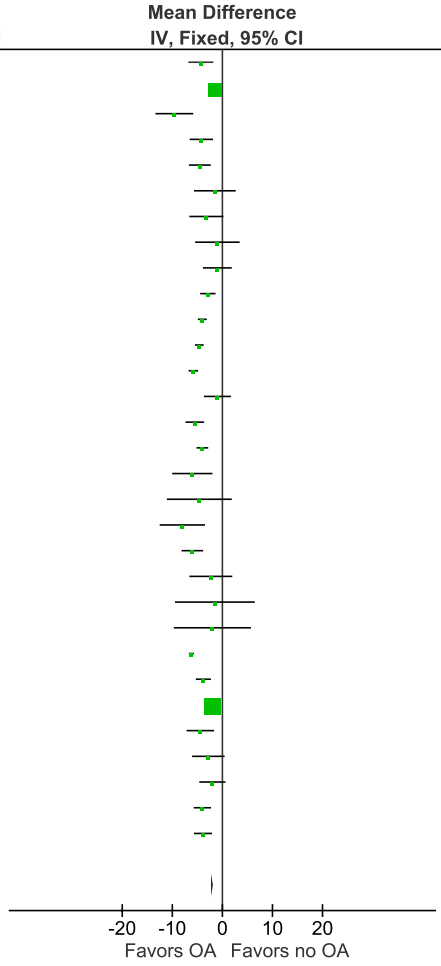

Figure 48—Custom, Titratable OAs for OSA (ESS).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	9.2	0.4	85	10.7	0.4	85	8.3%	-1.50 [-1.62, -1.38]
Bloch 2000	8.9	3.3	24	13.1	4.8	24	4.1%	-4.20 [-6.53, -1.87]
Campbell 2009	7.8	4.5	16	11.6	4.7	16	2.9%	-3.80 [-6.99, -0.61]
Cunali 2011	11	6	14	12	6	14	1.8%	-1.00 [-5.44, 3.44]
Gagnadoux 2009	7.7	4	59	10.6	4.5	59	5.8%	-2.90 [-4.44, -1.36]
Gauthier 2009	9.3	1.2	16	13.9	1.3	16	7.3%	-4.60 [-5.47, -3.73]
Gauthier 2009	9.9	1.3	16	13.9	1.3	16	7.2%	-4.00 [-4.90, -3.10]
Gauthier 2011	7.7	1	14	13.5	1.5	14	7.1%	-5.80 [-6.74, -4.86]
Ghazal 2009	4.5	3	48	10	5.9	48	5.0%	-5.50 [-7.37, -3.63]
Ghazal 2009	6.5	5.9	47	7.5	7.4	47	3.5%	-1.00 [-3.71, 1.71]
Gotsopoulos 2002	7	1	73	11	5	73	6.6%	-4.00 [-5.17, -2.83]
Hoekema 2007a	5	4.1	20	11	8.2	20	2.1%	-6.00 [-10.02, -1.98]
Hoekema 2007b	6.7	6	9	11.3	7.9	9	0.9%	-4.60 [-11.08, 1.88]
Hoekema 2008a	4.5	5.4	12	12.5	5.9	12	1.7%	-8.00 [-12.53, -3.47]
Hoekema 2008b	6.9	5.5	51	12.9	5.6	51	4.4%	-6.00 [-8.15, -3.85]
Lawton 2005	8	10.4	16	10	11.8	16	0.7%	-2.00 [-9.71, 5.71]
Lawton 2005	8.5	10.4	15	10	11.8	15	0.6%	-1.50 [-9.46, 6.46]
Mehta 2001	3.9	0.6	24	10.1	1.1	24	7.9%	-6.20 [-6.70, -5.70]
Naismith 2005	7.1	4.5	73	10.9	4.8	73	5.8%	-3.80 [-5.31, -2.29]
Phillips 2013	7.2	0.4	108	9.1	0.4	108	8.3%	-1.90 [-2.01, -1.79]
Trzepizur 2009	8.2	3.7	12	11	4.4	12	2.8%	-2.80 [-6.05, 0.45]
Zhou 2012	8	2.5	16	11.9	2.7	16	5.2%	-3.90 [-5.70, -2.10]
Total (95% CI)			**768**			**768**	**100.0%**	**-3.95 [-4.61, -3.28]**

Heterogeneity: Tau² = 1.39; Chi² = 518.43, df = 21 (P < 0.00001); I² = 96%
Test for overall effect: Z = 11.61 (P < 0.00001)

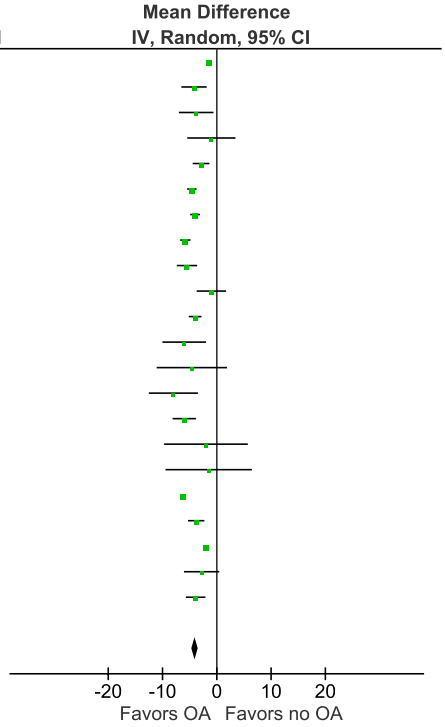

Figure 49—Custom, Non-Titratable OAs for OSA (ESS).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Andren 2012	6.7	5.4	36	11	5.4	36	23.0%	-4.30 [-6.79, -1.81]
Johnston 2002	11.6	6.7	18	13.9	6.4	45	11.0%	-2.30 [-5.92, 1.32]
Tegelberg 2012	6.8	4.5	45	11.2	4.1	45	45.1%	-4.40 [-6.18, -2.62]
Vanderveken 2008	5	4	23	7	5	23	20.9%	-2.00 [-4.62, 0.62]
Total (95% CI)			**122**			**149**	**100.0%**	**-3.65 [-4.84, -2.45]**

Heterogeneity: Tau² = 0.00; Chi² = 3.01, df = 3 (P = 0.39); I² = 0%
Test for overall effect: Z = 5.97 (P < 0.00001)

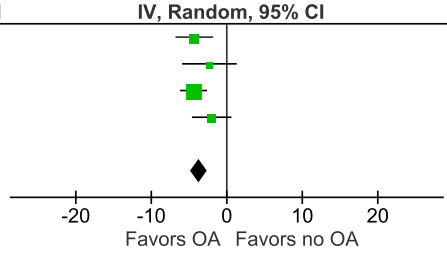

Figure 50—OAs vs. CPAP for OSA (ESS).

Study or Subgroup	OA Mean	SD	Total	CPAP Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	9.2	0.4	85	9.2	0.4	89	44.1%	0.00 [-0.12, 0.12]
Engleman 2002	12	5	19	8	5	29	1.0%	4.00 [1.11, 6.89]
Gagnadoux 2009	7.7	4	59	8.2	3.9	59	4.0%	-0.50 [-1.93, 0.93]
Hoekema 2007a	5	4.1	20	5	6.7	27	0.9%	0.00 [-3.10, 3.10]
Hoekema 2007b	6.7	6	9	5.5	4.1	10	0.4%	1.20 [-3.47, 5.87]
Hoekema 2008a	4.5	5.4	12	5	5.2	13	0.5%	-0.50 [-4.66, 3.66]
Hoekema 2008b	6.9	5.5	49	5.9	4.8	50	2.1%	1.00 [-1.04, 3.04]
Phillips 2013	7.2	0.4	108	7.5	0.4	108	44.7%	-0.30 [-0.41, -0.19]
Tan 2002	9	5.1	24	8.1	4.1	24	1.3%	0.90 [-1.72, 3.52]
Tzepizur 2009	8.2	3.7	12	8.8	3.7	12	1.0%	-0.60 [-3.56, 2.36]
Total (95% CI)			**397**			**421**	**100.0%**	**-0.08 [-0.38, 0.21]**

Heterogeneity: Tau² = 0.05; Chi² = 24.06, df = 9 (P = 0.004); I² = 63%
Test for overall effect: Z = 0.55 (P = 0.58)

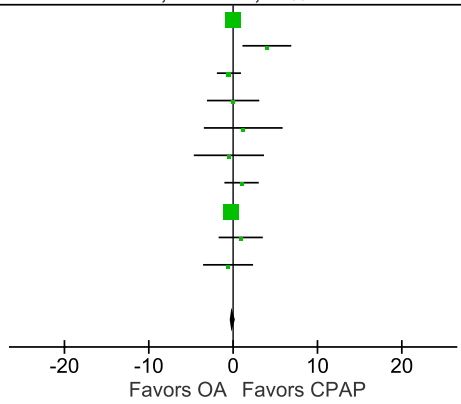

Figure 51—Summary of Findings: OAs Pre- vs. Post-Treatment for OSA (ESS).

OAs for OSA

Patient or population: Patients with OSA
Intervention: OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**OAs**				
ESS (Daytime sleepiness)		The mean ESS in the intervention groups was **3.81 lower** (4.39 to 3.23 lower)		971 (25 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 52—Summary of Findings: Custom OAs for OSA (ESS).

Custom OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom OAs**				
ESS (Daytime sleepiness)		The mean ESS in the intervention groups was **1.95 lower** (2.03 to 1.88 lower)		948 (25 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 53—Summary of Findings: Non-Custom OAs for OSA (ESS).

Non-custom OAs for OSA

Patient or population: Patients with OSA
Intervention: Non-custom OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Non-custom OAs**				
ESS (Daytime sleepiness)		The mean ESS in the intervention groups was **1.00 lower** (3.62 lower to 1.62 higher)		23 (1 study)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] CI of absolute effect crosses clinical decision threshold

Figure 54—Summary of Findings: Custom, Titratable OAs for OSA (ESS).

Custom, titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom, titratable OAs**				
ESS (Daytime sleepiness)		The mean ESS in the intervention groups was **3.95 lower** (4.61 to 3.28 lower)		768 (19 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 55—Summary of Findings: Custom, Non-Titratable OAs for OSA (ESS).

Custom, non-titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, non-titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom, non-titratable OAs**				
ESS (Daytime sleepiness)		The mean ESS in the intervention groups was **3.65 lower** (5.18 to 2.13 lower)		156 (8 studies)	⊕⊕⊕⊕ **high**	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Figure 56—Summary of Findings: OAs vs. CPAP for OSA (ESS).

OAs compared to CPAP for OSA

Patient or population: patients with OSA
Intervention: OAs
Comparison: CPAP

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	CPAP	**OAs**				
ESS (Daytime sleepiness)		The mean ESS in the intervention groups was **0.08 lower** (0.21 higher to 0.38 lower)		397 (10 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses the clinical decision threshold

Figure 57—OAs for OSA (Quality of Life, QOL; Short Form-36, SF-36).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	73.7	1.2	85	69.4	1.3	85	4.2%	4.30 [3.92, 4.68]
Blanco 2005	67	21.3	8	70.3	38.7	8	0.2%	-3.30 [-33.91, 27.31]
Blanco 2005	78.2	12.4	8	78.3	13.6	8	0.9%	-0.10 [-12.85, 12.65]
Blanco 2005	74.1	18.4	8	70.7	16.4	8	0.5%	3.40 [-13.68, 20.48]
Blanco 2005	61	20.7	8	60.7	22	8	0.4%	0.30 [-20.63, 21.23]
Blanco 2005	87.5	30.6	8	83.4	30.2	8	0.2%	4.10 [-25.69, 33.89]
Blanco 2005	77.7	46.6	8	81	37.7	8	0.1%	-3.30 [-44.84, 38.24]
Blanco 2005	50.7	8.4	8	49.3	18.8	8	0.7%	1.40 [-12.87, 15.67]
Blanco 2005	59.4	19.2	8	60.1	19.3	8	0.4%	-0.70 [-19.56, 18.16]
Cunali 2011	66	28	29	66	28	29	0.7%	0.00 [-14.41, 14.41]
Cunali 2011	54	40	29	32	34	29	0.4%	22.00 [2.89, 41.11]
Cunali 2011	51	26	29	44	21	29	0.9%	7.00 [-5.16, 19.16]
Cunali 2011	59	20	29	54	24	29	1.0%	5.00 [-6.37, 16.37]
Cunali 2011	44	19	29	31	15	29	1.5%	13.00 [4.19, 21.81]
Cunali 2011	76	28	29	58	29	29	0.7%	18.00 [3.33, 32.67]
Cunali 2011	59	44	29	40	40	29	0.3%	19.00 [-2.64, 40.64]
Cunali 2011	57	22	29	48	48	29	0.4%	9.00 [-10.22, 28.22]
Engleman 2002	45	10	19	49	6	19	2.5%	-4.00 [-9.24, 1.24]
Engleman 2002	48	11	19	45	12	19	1.9%	3.00 [-4.32, 10.32]
Ghazal 2009	73.2	8.6	47	69.4	14.1	47	2.8%	3.80 [-0.92, 8.52]
Ghazal 2009	80	6.6	48	73.5	13.2	48	3.0%	6.50 [2.33, 10.67]
Hoekema 2008b	67.3	42.5	49	40.7	40.3	51	0.6%	26.60 [10.35, 42.85]
Hoekema 2008b	78.8	21.5	49	71.8	23.3	51	1.5%	7.00 [-1.78, 15.78]
Hoekema 2008b	74	27.5	49	39.7	24.6	51	1.2%	34.30 [24.06, 44.54]
Hoekema 2008b	79.9	26.5	49	75.4	26.6	51	1.2%	4.50 [-5.91, 14.91]
Hoekema 2008b	63.8	21.2	49	39	18.6	51	1.7%	24.80 [16.97, 32.63]
Hoekema 2008b	78.9	37.1	49	70.6	41.5	51	0.6%	8.30 [-7.12, 23.72]
Hoekema 2008b	65.5	20.6	49	57.6	21.3	51	1.6%	7.90 [-0.31, 16.11]
Hoekema 2008b	77.5	16.5	49	70.9	17.8	51	2.0%	6.60 [-0.12, 13.32]
Hoekema 2008b	79.7	21.4	49	66.4	22.9	51	1.5%	13.30 [4.62, 21.98]
Lawton 2005	47.5	12.3	16	47	11.1	16	1.6%	0.50 [-7.62, 8.62]
Lawton 2005	45	9.9	16	47	11.1	16	1.9%	-2.00 [-9.29, 5.29]
Lawton 2005	68.9	18.7	16	74.4	21.5	16	0.7%	-5.50 [-19.46, 8.46]
Lawton 2005	66	11.8	16	68	10.9	16	1.7%	-2.00 [-9.87, 5.87]
Lawton 2005	70	18.8	16	68	10.9	16	1.1%	2.00 [-8.65, 12.65]
Lawton 2005	80.6	1.8	16	71.5	2.2	16	4.0%	9.10 [7.71, 10.49]
Lawton 2005	62	12.8	16	59.5	15.2	16	1.3%	2.50 [-7.24, 12.24]
Lawton 2005	187.5	18.5	16	175	24.7	16	0.7%	12.50 [-2.62, 27.62]
Lawton 2005	50	18.5	16	50	12.3	16	1.1%	0.00 [-10.89, 10.89]
Lawton 2005	68.9	12.1	16	66.7	14.8	16	1.4%	2.20 [-7.17, 11.57]
Lawton 2005	72.5	19.8	16	70	19.8	16	0.8%	2.50 [-11.22, 16.22]
Lawton 2005	200	8.2	16	200	24.7	16	0.9%	0.00 [-12.75, 12.75]
Lawton 2005	66.7	14.8	16	66.7	14.8	16	1.2%	0.00 [-10.26, 10.26]
Lawton 2005	50	12.3	16	50	12.3	16	1.5%	0.00 [-8.52, 8.52]
Lawton 2005	200	24.7	16	175	24.7	16	0.5%	25.00 [7.88, 42.12]
Lawton 2005	200	24.7	16	200	24.7	16	0.5%	0.00 [-17.12, 17.12]
Lawton 2005	65	19.8	16	70	19.8	16	0.8%	-5.00 [-18.72, 8.72]
Lawton 2005	75.5	19.2	16	74.4	21.5	16	0.7%	1.10 [-13.02, 15.22]
Phillips 2013	74.4	1.6	108	68.1	1.8	108	4.2%	6.30 [5.85, 6.75]
Phillips 2013	81.6	2.9	108	65.1	4	108	4.1%	16.50 [15.57, 17.43]
Phillips 2013	60.1	2	108	48.9	2.1	108	4.2%	11.20 [10.65, 11.75]
Phillips 2013	84.7	1.9	108	82.3	1.8	108	4.2%	2.40 [1.91, 2.89]
Phillips 2013	80.6	1.8	108	71.5	2.2	108	4.2%	9.10 [8.56, 9.64]
Phillips 2013	81	1.9	108	76.5	2.2	108	4.2%	4.50 [3.95, 5.05]
Phillips 2013	67.4	2	108	63.1	2	108	4.2%	4.30 [3.77, 4.83]
Phillips 2013	84.8	1.8	108	77.6	2.3	108	4.2%	7.20 [6.65, 7.75]
Phillips 2013	79.9	2.9	108	70.4	3.4	108	4.1%	9.50 [8.66, 10.34]
Phillips 2013	75.3	1.5	108	71.7	1.5	108	4.2%	3.60 [3.20, 4.00]
Total (95% CI)			**2323**			**2341**	**100.0%**	**6.41 [5.08, 7.75]**

Heterogeneity: Tau² = 10.99; Chi² = 1675.31, df = 57 (P < 0.00001); I² = 97%
Test for overall effect: Z = 9.43 (P < 0.00001)

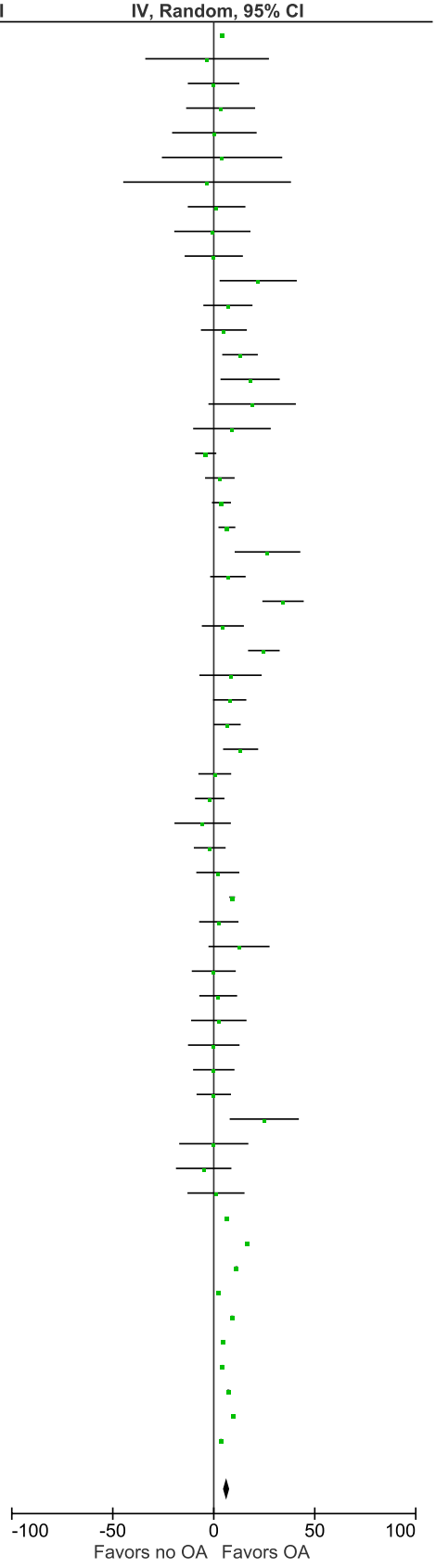

Figure 58—Custom, Titratable OAs for OSA (QOL; SF-36).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	73.7	1.2	85	69.4	1.3	85	4.8%	4.30 [3.92, 4.68]
Cunali 2011	54	40	29	32	34	29	0.5%	22.00 [2.89, 41.11]
Cunali 2011	66	28	29	66	28	29	0.8%	0.00 [-14.41, 14.41]
Cunali 2011	59	20	29	54	24	29	1.2%	5.00 [-6.37, 16.37]
Cunali 2011	51	26	29	44	21	29	1.1%	7.00 [-5.16, 19.16]
Cunali 2011	76	28	29	58	29	29	0.8%	18.00 [3.33, 32.67]
Cunali 2011	44	19	29	31	15	29	1.7%	13.00 [4.19, 21.81]
Cunali 2011	59	44	29	40	40	29	0.4%	19.00 [-2.64, 40.64]
Cunali 2011	57	22	29	48	48	29	0.5%	9.00 [-10.22, 28.22]
Ghazal 2009	80	6.6	48	73.5	13.2	48	3.4%	6.50 [2.33, 10.67]
Ghazal 2009	73.2	8.6	47	69.4	14.1	47	3.1%	3.80 [-0.92, 8.52]
Hoekema 2008b	63.8	21.2	49	39	18.6	51	2.0%	24.80 [16.97, 32.63]
Hoekema 2008b	78.9	37.1	49	70.6	41.5	51	0.7%	8.30 [-7.12, 23.72]
Hoekema 2008b	79.7	21.4	49	66.4	22.9	51	1.7%	13.30 [4.62, 21.98]
Hoekema 2008b	78.8	21.5	49	71.8	23.3	51	1.7%	7.00 [-1.78, 15.78]
Hoekema 2008b	77.5	16.5	49	70.9	17.8	51	2.3%	6.60 [-0.12, 13.32]
Hoekema 2008b	79.9	26.5	49	75.4	26.6	51	1.3%	4.50 [-5.91, 14.91]
Hoekema 2008b	74	27.5	49	39.7	24.6	51	1.4%	34.30 [24.06, 44.54]
Hoekema 2008b	65.5	20.6	49	57.6	21.3	51	1.8%	7.90 [-0.31, 16.11]
Hoekema 2008b	67.3	42.5	49	40.7	40.3	51	0.7%	26.60 [10.35, 42.85]
Lawton 2005	72.5	19.8	16	70	19.8	16	0.9%	2.50 [-11.22, 16.22]
Lawton 2005	75.5	19.2	16	74.4	21.5	16	0.8%	1.10 [-13.02, 15.22]
Lawton 2005	70	18.8	16	68	10.9	16	1.3%	2.00 [-8.65, 12.65]
Lawton 2005	200	24.7	16	175	24.7	16	0.6%	25.00 [7.88, 42.12]
Lawton 2005	187.5	18.5	16	175	24.7	16	0.7%	12.50 [-2.62, 27.62]
Lawton 2005	68.9	12.1	16	66.7	14.8	16	1.6%	2.20 [-7.17, 11.57]
Lawton 2005	47.5	12.3	16	47	11.1	16	1.9%	0.50 [-7.62, 8.62]
Lawton 2005	62	12.8	16	59.5	15.2	16	1.5%	2.50 [-7.24, 12.24]
Lawton 2005	65	19.8	16	70	19.8	16	0.9%	-5.00 [-18.72, 8.72]
Lawton 2005	200	8.2	16	200	24.7	16	1.0%	0.00 [-12.75, 12.75]
Lawton 2005	67.8	10.4	16	66.7	14.8	16	1.7%	1.10 [-7.76, 9.96]
Lawton 2005	68.9	18.7	16	74.4	21.5	16	0.9%	-5.50 [-19.46, 8.46]
Lawton 2005	200	24.7	16	200	24.7	16	0.6%	0.00 [-17.12, 17.12]
Lawton 2005	53.5	16.4	16	59.5	15.2	16	1.2%	-6.00 [-16.96, 4.96]
Lawton 2005	66	11.5	16	68	10.9	16	2.0%	-2.00 [-9.76, 5.76]
Lawton 2005	45	9.9	16	47	11.1	16	2.1%	-2.00 [-9.29, 5.29]
Lawton 2005	50	12.3	16	50	18.5	16	1.3%	0.00 [-10.89, 10.89]
Phillips 2013	81.6	2.9	108	65.1	4	108	4.7%	16.50 [15.57, 17.43]
Phillips 2013	74.4	1.6	108	68.1	1.8	108	4.8%	6.30 [5.85, 6.75]
Phillips 2013	75.3	1.5	108	71.7	1.5	108	4.8%	3.60 [3.20, 4.00]
Phillips 2013	81	1.9	108	76.5	2.2	108	4.7%	4.50 [3.95, 5.05]
Phillips 2013	79.9	2.9	108	70.4	3.4	108	4.7%	9.50 [8.66, 10.34]
Phillips 2013	60.1	2	108	48.9	2.1	108	4.7%	11.20 [10.65, 11.75]
Phillips 2013	67.4	2	108	63.1	2	108	4.7%	4.30 [3.77, 4.83]
Phillips 2013	84.7	1.9	108	82.3	1.8	108	4.7%	2.40 [1.91, 2.89]
Phillips 2013	84.8	1.8	108	77.6	2.3	108	4.7%	7.20 [6.65, 7.75]
Phillips 2013	80.6	1.8	108	71.5	2.2	108	4.7%	9.10 [8.56, 9.64]
Total (95% CI)			**2205**			**2223**	**100.0%**	**6.84 [5.42, 8.26]**

Heterogeneity: Tau² = 11.02; Chi² = 1641.34, df = 46 (P < 0.00001); I² = 97%
Test for overall effect: Z = 9.43 (P < 0.00001)

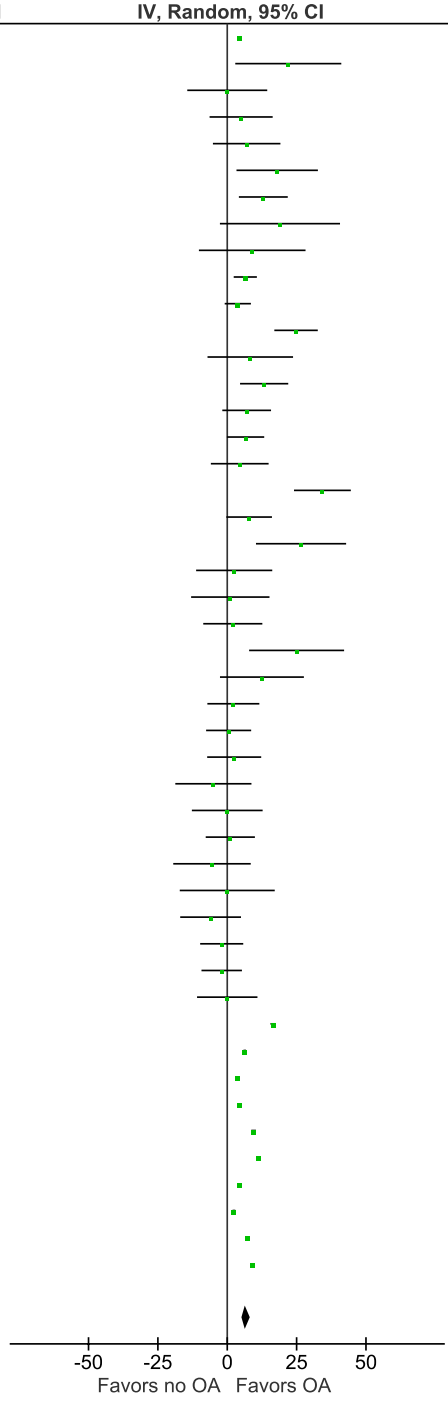

Figure 59—Custom, Non-Titratable OAs for OSA (QOL; SF-36).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Blanco 2005	50.7	8.4	8	49.3	18.8	8	6.3%	1.40 [-12.87, 15.67]
Blanco 2005	78.2	12.4	8	78.3	13.6	8	7.9%	-0.10 [-12.85, 12.65]
Blanco 2005	59.4	19.2	8	60.1	19.3	8	3.6%	-0.70 [-19.56, 18.16]
Blanco 2005	74.1	18.4	8	70.7	16.4	8	4.4%	3.40 [-13.68, 20.48]
Blanco 2005	67	21.3	8	70.3	38.7	8	1.4%	-3.30 [-33.91, 27.31]
Blanco 2005	61	20.7	8	60.7	22	8	2.9%	0.30 [-20.63, 21.23]
Blanco 2005	77.7	46.6	8	81	37.7	8	0.7%	-3.30 [-44.84, 38.24]
Blanco 2005	87.5	30.6	8	83.4	30.2	8	1.5%	4.10 [-25.69, 33.89]
Engleman 2002	45	10	19	49	6	19	47.0%	-4.00 [-9.24, 1.24]
Engleman 2002	48	11	19	45	12	19	24.1%	3.00 [-4.32, 10.32]
Total (95% CI)			**102**			**102**	**100.0%**	**-0.95 [-4.55, 2.64]**

Heterogeneity: Tau² = 0.00; Chi² = 2.95, df = 9 (P = 0.97); I² = 0%
Test for overall effect: Z = 0.52 (P = 0.60)

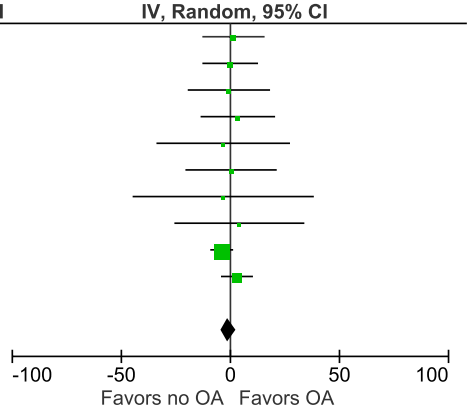

Figure 60—OAs vs. CPAP for OSA (QOL; SF-36).

Study or Subgroup	CPAP Mean	SD	Total	OA Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	73.7	1.2	85	74.1	1.2	89	7.8%	-0.40 [-0.76, -0.04]
Engleman 2002	47	10	29	45	10	19	2.4%	2.00 [-3.78, 7.78]
Engleman 2002	52	10	29	48	11	19	2.2%	4.00 [-2.14, 10.14]
Hoekema 2008b	67.3	42.5	49	71.5	40.4	50	0.4%	-4.20 [-20.54, 12.14]
Hoekema 2008b	78.9	37.1	49	77.2	38	50	0.5%	1.70 [-13.09, 16.49]
Hoekema 2008b	79.9	26.5	49	82.3	23.9	50	1.0%	-2.40 [-12.35, 7.55]
Hoekema 2008b	63.8	21.2	49	61.3	19.9	50	1.4%	2.50 [-5.60, 10.60]
Hoekema 2008b	77.5	16.5	49	75	16.2	50	2.1%	2.50 [-3.94, 8.94]
Hoekema 2008b	78.8	21.5	49	80.6	18.5	50	1.5%	-1.80 [-9.71, 6.11]
Hoekema 2008b	79.7	21.4	49	78.6	21.1	50	1.4%	1.10 [-7.27, 9.47]
Hoekema 2008b	65.5	20.6	49	60.9	23.4	50	1.3%	4.60 [-4.08, 13.28]
Hoekema 2008b	74	27.5	49	73.5	26.4	50	0.9%	0.50 [-10.12, 11.12]
Phillips 2013	67.4	2	108	65.7	1.9	108	7.7%	1.70 [1.18, 2.22]
Phillips 2013	81.6	2.9	108	78.8	3.3	108	7.5%	2.80 [1.97, 3.63]
Phillips 2013	81	1.9	108	76.2	2.1	108	7.7%	4.80 [4.27, 5.33]
Phillips 2013	79.9	2.9	108	81.7	3.2	108	7.5%	-1.80 [-2.61, -0.99]
Phillips 2013	60.1	2	108	56.3	2.2	108	7.7%	3.80 [3.24, 4.36]
Phillips 2013	84.8	1.8	108	79.7	2.2	108	7.7%	5.10 [4.56, 5.64]
Phillips 2013	74.4	1.6	108	72.6	1.7	108	7.8%	1.80 [1.36, 2.24]
Phillips 2013	80.6	1.8	108	77.1	2	108	7.7%	3.50 [2.99, 4.01]
Phillips 2013	84.7	1.9	108	83.7	1.9	108	7.7%	1.00 [0.49, 1.51]
Phillips 2013	75.3	1.5	108	72.6	1.6	108	7.8%	2.70 [2.29, 3.11]
Total (95% CI)			**1664**			**1657**	**100.0%**	**2.18 [1.10, 3.25]**

Heterogeneity: Tau² = 3.84; Chi² = 595.43, df = 21 (P < 0.00001); I² = 96%
Test for overall effect: Z = 3.95 (P < 0.0001)

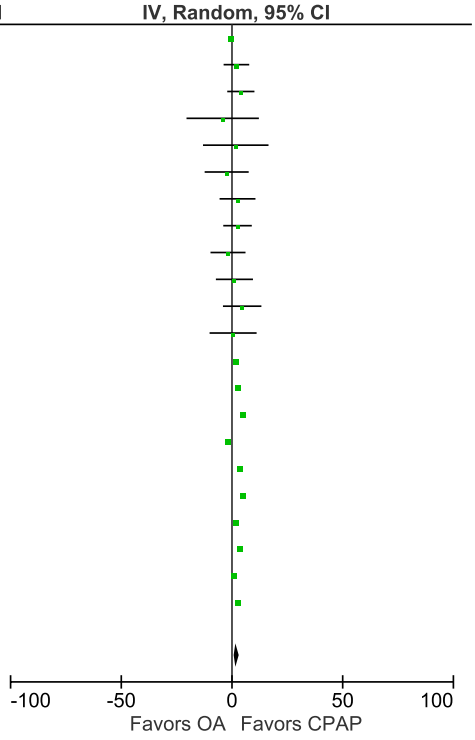

Figure 61—Summary of Findings: OAs Pre- vs. Post-Treatment for OSA (Quality of Life; QOL).

OAs for OSA

Patient or population: Patients with OSA
Intervention: OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**OAs**				
QOL		The mean QOL in the intervention groups was **6.41 higher** (5.08 to 7.75 higher)		2323 (8 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 62—Summary of Findings: Custom, Titratable OAs for OSA (QOL).

Custom, titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom, titratable OAs**				
QOL		The mean QOL in the intervention groups was **6.84 higher** (5.42 to 8.26 higher)		2205 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 63—Summary of Findings: Custom, Non-Titratable OAs for OSA (QOL).

Custom, non-titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, non-titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom, non-titratable OAs**				
QOL		The mean QOL in the intervention groups was **0.95 lower** (4.55 lower to 2.64 higher)		102 (2 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 64—Summary of Findings: OAs vs. CPAP for OSA (QOL).

OAs compared to CPAP for OSA

Patient or population: patients with OSA
Intervention: OAs
Comparison: CPAP

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	CPAP	OAs				
QOL		The mean QOL in the intervention groups was **2.18 lower** (1.1 to 3.25 lower)		1664 (4 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval;

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 65—OAs for OSA (Systolic blood pressure).

	Post-treatment			Pre-treatment				Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Andren 2012	134.6	10.4	36	136.9	10.8	36	4.2%	-2.30 [-7.20, 2.60]	
Barnes 2004	126.7	1	80	126.5	1	80	19.0%	0.20 [-0.11, 0.51]	
Gauthier 2009	123.6	1.7	16	127.3	2.8	16	13.9%	-3.70 [-5.31, -2.09]	
Gauthier 2009	123	2.2	16	127.3	2.8	16	13.2%	-4.30 [-6.04, -2.56]	
Gauthier 2011	123.7	2.4	14	128	3.2	14	11.6%	-4.30 [-6.40, -2.20]	
Gotsopoulos 2004	125.2	1.3	61	127.3	1.3	61	18.6%	-2.10 [-2.56, -1.64]	
Phillips 2013	123.9	1.1	108	123.9	1.2	108	19.0%	0.00 [-0.31, 0.31]	
Trzepizur 2009	140	22.2	12	150	11.1	12	0.6%	-10.00 [-24.04, 4.04]	
Total (95% CI)			**343**			**343**	**100.0%**	**-2.09 [-3.22, -0.96]**	

Heterogeneity: Tau² = 1.73; Chi² = 124.02, df = 7 (P < 0.00001); I² = 94%
Test for overall effect: Z = 3.62 (P = 0.0003)

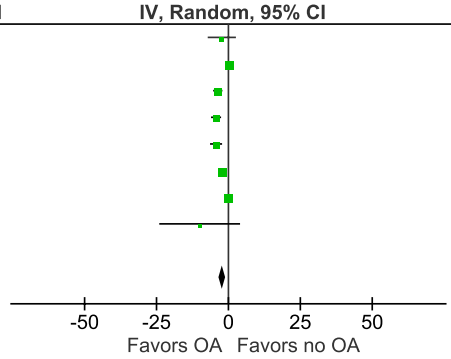

Figure 66—OAs for OSA (Diastolic blood pressure).

	Post-treatment			Pre-treatment				Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Andren 2012	81.6	8.7	36	83.8	8.7	36	5.4%	-2.20 [-6.22, 1.82]	
Barnes 2004	76.3	0.7	80	76.3	0.8	80	18.1%	0.00 [-0.23, 0.23]	
Gauthier 2009	84.6	2.3	16	91	2.7	16	12.7%	-6.40 [-8.14, -4.66]	
Gauthier 2009	85	1.9	16	91	2.7	16	13.2%	-6.00 [-7.62, -4.38]	
Gauthier 2011	81.9	2.3	14	92	3	14	11.6%	-10.10 [-12.08, -8.12]	
Gotsopoulos 2004	76.2	0.9	61	77.7	0.9	61	18.0%	-1.50 [-1.82, -1.18]	
Phillips 2013	77.1	0.7	108	77.3	0.8	108	18.2%	-0.20 [-0.40, 0.00]	
Trzepizur 2009	63	5.2	12	61	9.6	12	2.8%	2.00 [-4.18, 8.18]	
Total (95% CI)			**343**			**343**	**100.0%**	**-3.15 [-4.26, -2.03]**	

Heterogeneity: Tau² = 1.78; Chi² = 244.23, df = 7 (P < 0.00001); I² = 97%
Test for overall effect: Z = 5.52 (P < 0.00001)

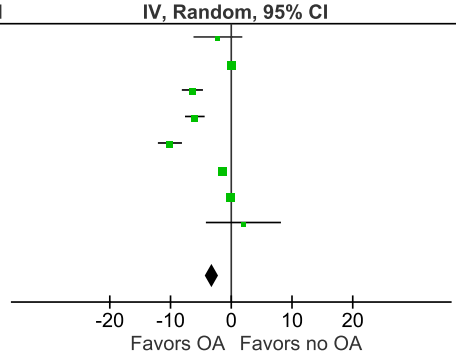

Figure 67—Custom, Titratable OAs for OSA (Systolic blood pressure).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	126.7	1	80	126.5	1	80	18.8%	0.20 [-0.11, 0.51]
Gauthier 2009	123	2.2	16	127.3	2.8	16	13.4%	-4.30 [-6.04, -2.56]
Gauthier 2009	123.6	1.7	16	127.3	2.8	16	14.0%	-3.70 [-5.31, -2.09]
Gauthier 2011	123.7	2.4	14	128	3.2	14	11.8%	-4.30 [-6.40, -2.20]
Gotsopolous 2004	125.2	1.3	61	127.3	1.3	61	18.5%	-2.10 [-2.56, -1.64]
Phillips 2013	123.9	1.1	108	123.9	1.2	108	18.8%	0.00 [-0.31, 0.31]
Trzepizur 2009	140.5	7.4	12	149.3	3.7	12	4.7%	-8.80 [-13.48, -4.12]
Total (95% CI)			**307**			**307**	**100.0%**	**-2.37 [-3.55, -1.20]**

Heterogeneity: Tau² = 1.89; Chi² = 133.93, df = 6 (P < 0.00001); I² = 96%
Test for overall effect: Z = 3.95 (P < 0.0001)

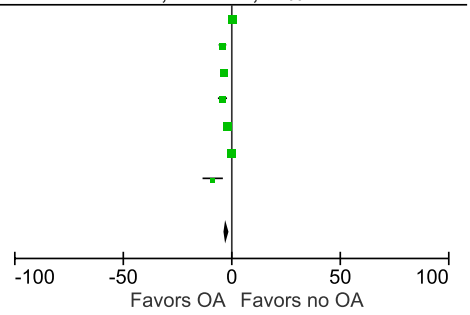

Figure 68—Custom, Titratable OAs for OSA (Diastolic blood pressure).

Study or Subgroup	Post-treatment Mean	SD	Total	Pre-treatment Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	76.3	0.7	80	76.3	0.8	80	17.6%	0.00 [-0.23, 0.23]
Gauthier 2009	84.6	2.3	16	92	3	16	11.9%	-7.40 [-9.25, -5.55]
Gauthier 2009	85	1.9	16	91	2.7	16	12.9%	-6.00 [-7.62, -4.38]
Gauthier 2011	81.9	2.3	14	92	3	14	11.3%	-10.10 [-12.08, -8.12]
Gotsopolous 2004	76.4	0.9	61	77.7	0.9	61	17.5%	-1.30 [-1.62, -0.98]
Phillips 2013	77.1	0.7	108	77.3	0.8	108	17.7%	-0.20 [-0.40, 0.00]
Trzepizur 2009	62.8	1.7	12	60.2	3.2	12	11.1%	2.60 [0.55, 4.65]
Total (95% CI)			**307**			**307**	**100.0%**	**-2.77 [-3.88, -1.67]**

Heterogeneity: Tau² = 1.80; Chi² = 246.54, df = 6 (P < 0.00001); I² = 98%
Test for overall effect: Z = 4.91 (P < 0.00001)

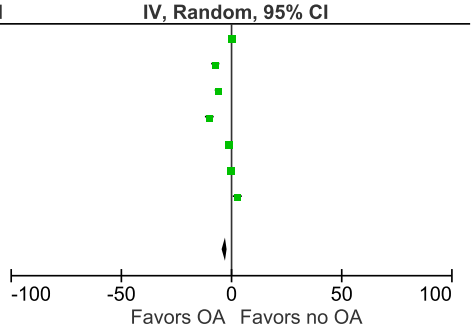

Figure 69—OAs vs. CPAP for OSA (Systolic blood pressure).

Study or Subgroup	OA Mean	SD	Total	CPAP Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	126.7	1	80	127.3	1.2	80	40.1%	-0.60 [-0.94, -0.26]
Phillips 2013	123.9	1.1	108	124.4	1	108	59.8%	-0.50 [-0.78, -0.22]
Trzepizur 2009	140	22.2	12	142	14.8	14	0.0%	-2.00 [-16.76, 12.76]
Total (95% CI)			**200**			**202**	**100.0%**	**-0.54 [-0.76, -0.32]**

Heterogeneity: Tau² = 0.00; Chi² = 0.23, df = 2 (P = 0.89); I² = 0%
Test for overall effect: Z = 4.88 (P < 0.00001)

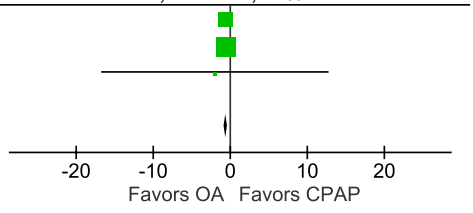

Figure 70—OAs vs. CPAP for OSA (Diastolic blood pressure).

Study or Subgroup	OA Mean	SD	Total	CPAP Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	76.3	0.7	80	76.7	0.8	80	46.2%	-0.40 [-0.63, -0.17]
Phillips 2013	77.1	0.7	108	77.2	0.7	108	53.5%	-0.10 [-0.29, 0.09]
Trzepizur 2009	63	5.2	12	64	7.4	14	0.3%	-1.00 [-5.87, 3.87]
Total (95% CI)			**200**			**202**	**100.0%**	**-0.24 [-0.50, 0.02]**

Heterogeneity: Tau² = 0.02; Chi² = 3.98, df = 2 (P = 0.14); I² = 50%
Test for overall effect: Z = 1.84 (P = 0.07)

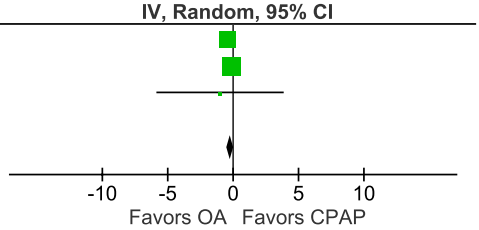

Figure 71—Summary of Findings: OAs for OSA (Hypertension).

OAs for OSA

Patient or population: Patients with OSA
Intervention: OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**OAs**				
Systolic blood pressure		The mean systolic blood pressure in the intervention groups was **2.09 lower** (3.22 to 0.96 lower)		343 (7 studies)	⊕⊕⊕⊖ **moderate**[1]	
Diastolic blood pressure		The mean diastolic blood pressure in the intervention groups was **3.15 lower** (4.26 to 2.03 lower)		343 (7 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 72—Summary of Findings: Custom, Titratable OAs for OSA (Hypertension).

Custom, titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom, titratable OAs**				
Systolic blood pressure		The mean systolic blood pressure in the intervention groups was **2.37 lower** (1.20 to 3.55 lower)		307 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	
Diastolic blood pressure		The mean diastolic blood pressure in the intervention groups was **2.77 lower** (1.67 to 3.88 lower)		307 (6 studies)	⊕⊕⊕⊖ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high

Figure 73—Summary of Findings: Custom, Non-Titratable OAs for OSA (Hypertension).

Custom, non-titratable OAs for OSA

Patient or population: Patients with OSA
Intervention: Custom, non-titratable OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**Custom, non-titratable OAs**				
Systolic blood pressure		The mean systolic blood pressure in the intervention groups was **2.30 lower** (7.2 to 2.6 lower)		36 (1 study)	⊕⊕⊕⊕ **high**	
Diastolic blood pressure		The mean diastolic blood pressure in the intervention groups was **2.2 lower** (6.22 to 1.82 lower)		36 (1 study)	⊕⊕⊕⊕ **high**	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Figure 74—Summary of Findings: OAs vs. CPAP for OSA (Hypertension).

OAs compared to CPAP for OSA

Patient or population: Patients with OSA
Intervention: OAs
Comparison: CPAP

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	CPAP	**OAs**				
Systolic blood pressure		The mean systolic blood pressure in the intervention groups was **0.54 lower** (0.76 to 0.32 lower)		202 (3 studies)	⊕⊕⊖⊖ **low**[1,2]	
Diastolic blood pressure		The mean diastolic blood pressure in the intervention groups was **0.24 lower** (0.5 lower to 0.02 higher)		202 (3 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 75—OAs vs. CPAP for OSA (Adherence).

Study or Subgroup	CPAP Mean	CPAP SD	CPAP Total	OA Mean	OA SD	OA Total	Weight	Mean Difference IV, Random, 95% CI
Barnes 2004	3.6	0.3	89	5.5	0.3	85	11.1%	-1.90 [-1.99, -1.81]
Doff 2012	6.9	1.3	39	7.2	0.8	36	10.3%	-0.30 [-0.78, 0.18]
Doff 2013	6.7	1.3	34	7.1	0.8	29	10.2%	-0.40 [-0.93, 0.13]
Engleman 2002	4.9	2.4	29	5	2.3	19	7.0%	-0.10 [-1.45, 1.25]
Gagnadoux 2009	6	2.2	29	7	5.2	28	4.7%	-1.00 [-3.09, 1.09]
Hoekema 2007a	6.3	1.3	27	7.1	1.1	20	9.7%	-0.80 [-1.49, -0.11]
Hoekema 2007b	6.7	1.4	10	7	0.9	9	8.2%	-0.30 [-1.35, 0.75]
Hoekema 2008a	7	0.7	13	6.8	1.3	12	9.1%	0.20 [-0.63, 1.03]
Hoekema 2008b	6.5	1.6	50	6.9	1	49	10.2%	-0.40 [-0.92, 0.12]
Phillips 2013	5.2	2	108	6.5	1.3	108	10.4%	-1.30 [-1.75, -0.85]
Trzepizur 2009	5.6	1.2	14	6.8	1	12	9.0%	-1.20 [-2.05, -0.35]
Total (95% CI)			**442**			**407**	**100.0%**	**-0.70 [-1.30, -0.11]**

Heterogeneity: Tau² = 0.82; Chi² = 142.38, df = 10 (P < 0.00001); I² = 93%
Test for overall effect: Z = 2.34 (P = 0.02)

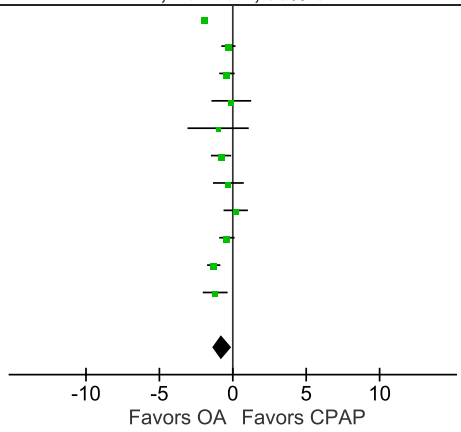

Figure 76—Summary of Findings: OAs vs. CPAP for OSA (Adherence).

OAs compared to CPAP for OSA

Patient or population: Patients with OSA
Intervention: OAs
Comparison: CPAP

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	CPAP	OAs				
Adherence (hrs./night)		The mean adherence (h/night) in the intervention groups was **0.70 higher** (0.11 to 1.30 higher)		442 (11 studies)	⊕⊕⊖⊖ **low**[1,2]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] I squared is high
[2] CI of absolute effect crosses clinical decision threshold

Figure 77—OAs for OSA (Side Effects).

Study or Subgroup	Post-treatment Events	Post-treatment Total	Pre-treatment Events	Pre-treatment Total	Weight	Odds Ratio M-H, Random, 95% CI
Aarab 2011b	2	35	0	35	10.0%	5.30 [0.25, 114.47]
Barnes 2004	2	99	0	99	10.2%	5.10 [0.24, 107.65]
Blanco 2005	5	20	0	20	10.8%	14.55 [0.75, 283.37]
Ferguson 1996	6	25	0	25	11.0%	17.00 [0.90, 320.37]
Ferguson 1997	1	20	0	20	8.9%	3.15 [0.12, 82.16]
Ghazal 2009	6	47	0	47	11.2%	14.88 [0.81, 272.17]
Ghazal 2009	4	48	0	48	10.9%	9.81 [0.51, 187.40]
Hoekema 2008b	1	15	0	15	8.8%	3.21 [0.12, 85.20]
Phillips 2013	1	60	0	60	9.1%	3.05 [0.12, 76.39]
Tan 2002	1	24	0	24	9.0%	3.13 [0.12, 80.68]
Total (95% CI)		**393**		**393**	**100.0%**	**6.65 [2.51, 17.62]**
Total events	29		0			

Heterogeneity: Tau² = 0.00; Chi² = 1.95, df = 9 (P = 0.99); I² = 0%
Test for overall effect: Z = 3.81 (P = 0.0001)

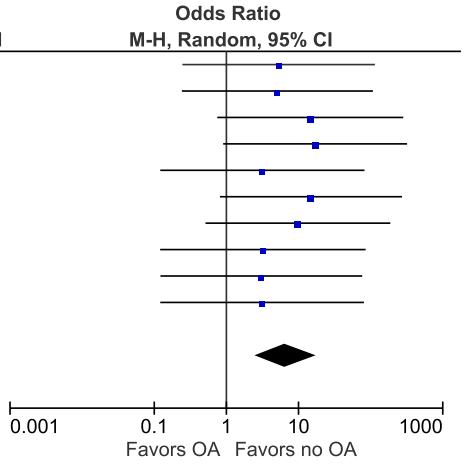

Figure 78—OAs vs. CPAP for OSA (Side Effects).

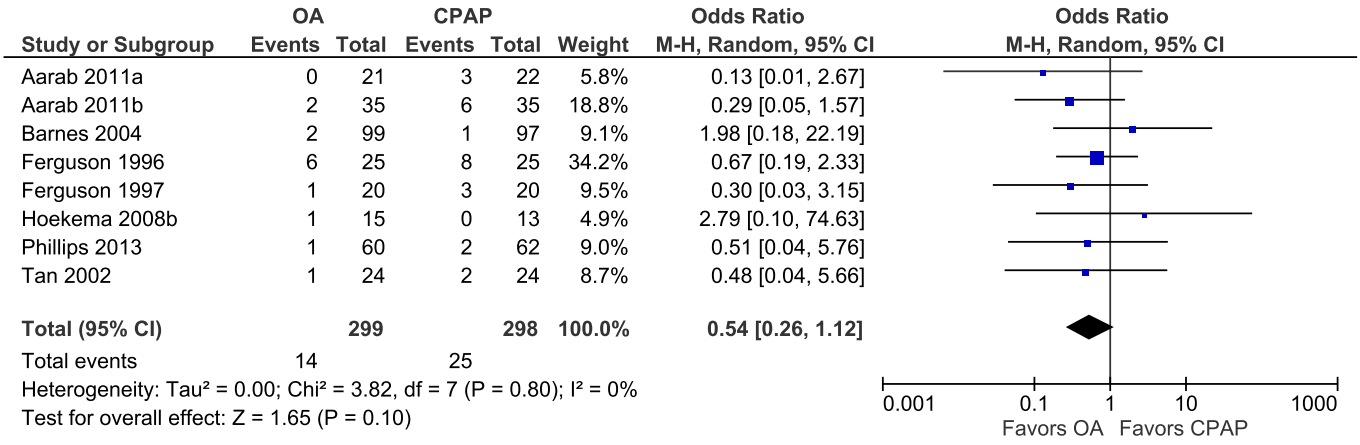

Figure 79—Summary of Findings: OAs for OSA (Side Effects).

OAs for OSA

Patient or population: Patients with OSA
Intervention: OAs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	**OAs**				
Discontinuation of therapy from side effects			**RR 6.65** (2.51 to 17.62)	786 (9 studies)	⊕⊕⊕⊕ **high**	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Figure 80—Summary of Findings: OAs vs. CPAP for OSA (Side Effects).

OAs compared to CPAP for OSA

Patient or population: Patients with OSA
Intervention: OAs
Comparison: CPAP

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	CPAP	**OAs**				
Discontinuation of therapy from side effects	**84 per 1000**	**45 per 1000** (22 to 94)	**RR 0.54** (0.26 to 1.12)	597 (8 studies)	⨁⨁⨁⨀ **moderate**[1]	

*The basis for the **assumed risk** (e.g., the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio

GRADE Working Group quality of evidence:
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] CI of absolute effect crosses the clinical decision threshold

CASE REPORTS

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Combination Therapy of Oral Appliance and Auto-Titrating CPAP of Patient with Edentulous Maxillary Arch

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This is a case study demonstrating combination therapy between an auto-titrating CPAP (continuous positive airway pressure) and oral appliance in a patient with an edentulous maxillary arch. Results demonstrated a decrease in average and mean CPAP pressure as well as a decrease in AHI (apnea hypopnea index) when combination therapy (oral appliance in conjunction with auto CPAP) is used versus auto-titrating CPAP alone.

Keywords: combination therapy, oral appliance, edentulous, auto CPAP

Citation: Eaton MJ, Tucker JH. Combination therapy of oral appliance and auto-titrating CPAP of patient with edentulous maxillary arch. *Journal of Dental Sleep Medicine* 2015;2(3):127–128.

Combination therapy has been shown to increase efficacy of treatment of obstructive sleep apnea with combination of PAP therapy and oral appliance. It has also been shown to decrease optimal pressure and apnea hypopnea index.[1] A previous case study has demonstrated combination therapy with use of an oral appliance and an auto-titrating CPAP unit.[2] This case study incorporates combination therapy for a patient with an edentulous maxillary arch. Combination therapy should be attempted to help improve efficacy of treatment and enhance disease alleviation when needed. Combination therapy should begin to be looked at as standard of care rather than taboo following a single treatment modality.[3]

REPORT OF CASE

A 57-year-old Caucasian male presented inquiring about oral appliance therapy. Patient was currently being treated with an auto-titrating CPAP. He complained of mask leaks and high pressures. The patient had referred himself to a sleep physician approximately 1 year previously because of excessive daytime sleepiness and complaints from his spouse of loud snoring and witnessed apneas. The patient underwent a split-night sleep study at that time. The split-night polysomnogram was interpreted by an American Academy of Sleep Medicine-accredited sleep physician, resulting to a diagnosis of severe obstructive sleep apnea. The patient exhibited an apnea-hypopnea index (AHI) of 63/h and oxyhemoglobin desaturations to a nadir of 74% during the baseline portion of study. There was a highly positional component to the OSA during polysomnography. During the CPAP titration portion of the study, the patient struggled to fall asleep with CPAP and was only able to do so on his side. He was titrated to a pressure of 13 cm H_2O, on his side, at which mild snoring was noted. The physician's opinion was that a pressure of 13 cm H_2O would likely be insufficient in supine position.

Upon presentation, patient's body mass index was 31 kg/m^2 and neck size was 18 inches. History of present illness included witnessed loud snoring and apneas by patient's spouse, multiple sclerosis, acute sleep attacks with cataplexy, optic neuritis, and vertigo. Past medical history included nicotine addiction, coronary artery disease, and multiple sclerosis. Past surgical history included an angioplasty for coronary artery disease. Medications included Copaxone, simvastatin, vitamin D3, and baby aspirin; he had no known drug allergies.

The patient was edentulous on the maxillary arch and had a well-fitting complete denture. He was missing teeth #17, 18, 20, 32 on mandibular arch and exhibited generalized mild periodontitis with localized moderate periodontitis on LR.

Patient's denture was in a Class I relationship with mandibular teeth. The oropharynx was characterized by a very low-arched palate (Mallampati IV). Tonsils had a grade I presentation. He had a large tongue with scalloping of the lateral borders. The temporomandibular joints, muscles of mastication, and mandibular range of motion were within normal limits. Consultation report to the physician stated an attempt could be made to treat the patient with an oral appliance.

A prescription for an oral appliance was received from the sleep physician, stating need for combination therapy due to high pressures and unresolved apneas. A dual laminate Herbst style oral appliance with telescopic arms was fabricated for the patient. This appliance was chosen because the silicone based inner lining was thought to easily adapt to denture.

The oral appliance inserted easily upon delivery. At one-week follow-up, patient stated he was able to sleep through 1st and 2nd nights easily with both the appliance and auto CPAP. On the 3rd and 4th nights he only used the appliance between 1–4 hours and had not worn it since because of sores in the area of the maxillary anterior. Adjustment was made to the oral appliance to loosen the fit of anterior denture teeth. The patient stated that appliance felt more comfortable following adjustment. The patient was placed on titration protocol. At one month follow-up post-insertion, the patient said that he sleeps easily with both the appliance and auto CPAP. A small sore was noted in the area of the left maxillary canine eminence. A small adjustment was made to the denture in area corresponding to sore as indicated by Thompson marker. The patient reported he has decreased daytime sleepiness and says auto-CPAP seems much more tolerable.

Table 1—Auto CPAP Summary.

	Auto CPAP Alone	Combination Therapy (Auto PAP + Oral Appliance)
Auto CPAP mean pressure	13.5 cm H_2O	8.5 cm H_2O
Auto CPAP peak average pressure	15.3 cm H_2O	10.5 cm H_2O
Average device pressure ≤ 90% of the time	15.3 cm H_2O	9.6 cm H_2O
Average AHI	11.4	6

He felt the appliance was working well. The patient was asked to make no further turns. A decision was made to wait to see the auto-CPAP data to evaluate the efficacy of combination therapy before undertaking any further titration.

Table 1 shows summary data from Phillips Respronics auto CPAP. The patient used a Mirage Quattro full face mask for both data ranges. Data were collected from patient's auto CPAP card. Data downloads were over approximately 2–3 month segments. The data showed a 5 cm H_2O decrease in mean pressure of combination therapy vs. auto CPAP alone. A decrease in AHI from 11.4 to 6.0 was also seen in combination therapy vs. auto CPAP alone.

DISCUSSION

Upon presentation, the patient was frustrated with auto CPAP due to high pressures. Combination therapy of auto PAP and oral appliance enabled further disease alleviation and increased patient satisfaction versus auto PAP alone. The patient was treated with an oral appliance fit to maxillary denture. Another technique would be to fabricate an oral appliance directly on edentulous arch.[4] This technique would help avoid adjustments to the patient's existing denture.

It is interesting to note in reading sleep physician's findings following his initial consult with patient, prior to polysomnogram, it states, "I have arranged a polysomnogram followed by CPAP titration. CPAP would be the only possible treatment. Indeed, he is wearing an upper denture." This is an example of need for enhanced education and awareness needed about dental sleep medicine.

Self-reported by patient was enhanced PAP compliance following combination therapy. Further research should be performed to examine relationship between PAP compliance due to decreased pressures seen with combination therapy between oral appliance and PAP.

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ABSTRACTS

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POSTER #001

Quantitative Evaluation of Upper Airway Using Nasoendoscopy for Prediction of Oral Appliance Treatment Outcome in Moderate and Severe Obstructive Sleep Apnea

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Introduction: Treatment with oral appliances (OA) is an alternative to continuous positive airway pressure (CPAP) for obstructive sleep apnea (OSA), although it appears to be less efficacious but more accepted by patients. As the efficacy of oral appliances varies greatly in patients with moderate to severe OSA, the prediction of OA treatment response is of key importance for efficient disease management. Nasoendoscopy has been previously reported as a useful approach to assess the upper airway and as a predictor of OA treatment. However, previous studies have been limited by qualitative assessments and retrospective study designs. In the present study, we report on the prospective and quantitative prediction of OA treatment outcomes using nasoendoscopy.

Method: A total of 61 patients with moderate to severe PSG-diagnosed OSA were prospectively and consecutively recruited for this study. The velopharynx and oropharynx was assessed via nasoendoscopy for each patient while awake and in the supine position. The airway expansion ratio, defined as the cross-sectional area of the airway during maximum mandibular protrusion divided by the area in centric occlusion, was then calculated at the level of both the velopharynx and oropharynx. Treatment success was defined as an AHI < 10/h in addition to a > 50% reduction in baseline AHI. A Mann-Whitney U-test was used to compare the expansion ratio between responders and non-responders. A Multivariable logistic regression analysis was performed, with OA treatment outcome as the dependent variable and the independent variables included age, body mass index (BMI), baseline AHI, and the airway expansion ratio in the velopharynx and oropharynx. A receiver operating characteristics (ROC) curve analysis was used to determine the prediction and the best cut-off value for the expansion ratio.

Results: The expansion ratio of the velopharynx was significantly greater in responders than in non-responders (2.9 vs 1.7, $P < 0.001$). Similarly, the expansion ratio of the oropharynx was also significantly greater in responders than in non-responders (3.4 vs 2.4, $P < 0.05$). Baseline AHI and the expansion ratio of the velopharynx were found to be independent predictors of OA treatment outcome with the multivariate logistic regression analysis. The estimated area under the curve (AUC) was 75.7 and the cut-off value of the expansion ratio was 2.00. The best combination of sensitivity/specificity and PPV/NPV was 85.7/80.8 and 85.7/80.8.

Conclusion: The airway expansion ratio of the velopharynx was significantly greater in responders than in non-responders, and a cut-off value of 2.0 provided a prediction with a high accuracy. Nasoendoscopy may have significant clinical utility in predicting success of OA treatment.

POSTER #002

Effects of a Non-Mandibular Advancement Device in Adults with Severe Obstructive Sleep Apnea

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Introduction: Mandibular repositioning devices (MRD) have been deployed for the management of mild, moderate and even severe cases of OSA, but there are some concerns regarding unwanted tooth movements, temporo-mandibular joint issues and facial profile changes using that approach. Biomimetic oral appliance therapy (BOAT) differs from conventional MRD therapy as it aims to correct the nasal airway through midfacial redevelopment followed by mandibular correction, which aims to improve the oropharyngeal airway in adults. In this investigation, we test the hypothesis that severe OSA can be addressed without primary mandibular advancement using BOAT.

Methods: In this preliminary study, we included 8 consecutive adults aged > 21yrs that had been diagnosed with severe OSA, following an overnight sleep study that had been interpreted by a Board certified sleep physician. Each subject that participated in this pilot study had failed to comply with CPAP therapy, and was treated under medical supervision by a dentist with advanced training in dental sleep medicine. At each monthly follow-up visit, examination for progress and adjustments of the devices were performed to optimize their efficacy. The mean apnea-hypopnea index (AHI) of the study sample was calculated prior to and after BOAT. The findings were subjected to statistical analysis, using paired t-tests.

Results: There were 5 females and 3 males that were included in this preliminary study. The mean age of the sample was approx. 60.2 yrs. ± 5.6. Prior to treatment the mean AHI of the study subjects was 46.6 ± 12.9. A further follow sleep study was done at a mean of 10.4 mos. ± 2.6. At this time, the AHI decreased significantly ($P < 0.001$) to a mean value of 13.9 ± 10.5 after BOAT, which represents a fall in the mean AHI by 70% for the study sample. Indeed, three subjects had an AHI of between 3.1 to 5.1 with no appliance in the mouth when the posttreatment sleep studies were done.

Conclusions: BOAT may be a useful method of managing severe cases of OSA in adults, and may represent an alternative to CPAP and MRD therapy. However, long-term follow up using a larger sample size is needed to reach more definitive conclusions on these initial findings.

POSTER #003

Oral Appliance Therapy Versus Nasal CPAP in Obstructive Sleep Apnea: A Randomized, Placebo-Controlled Trial on Sleep-Related Comorbidities

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Introduction: Obstructive sleep apnea (OSA) is associated with several other sleep disorders and sleep-related problems such as insomnia and daytime dysfunction. To our best knowledge, no randomized placebo-controlled trials have been performed comparing the effects of an objectively titrated mandibular advancement device (MAD) and Continuous Positive Airway Pressure (CPAP) on common sleep-related comorbidities. Therefore, the aim of this study was to compare the effects of an MAD with those of nasal CPAP (nCPAP) on symptoms of common sleep disorders and sleep-related problems.

Methods: This study is part of a randomized placebo-controlled trial in which different treatment effects of a titrated MAD are compared with those of nCPAP and an intra-oral placebo appliance in a parallel design. 64 mild/moderate OSA patients (52.0 ± 9.6 years) were randomly allocated to these three therapy groups. All patients filled out the Dutch Sleep Disorders Questionnaire (SDQ) twice: one before treatment and one after six months of treatment. The SDQ is a validated questionnaire that is designed for the assessment of common sleep disorders and sleep-related problems. Based on 88 questions, thirteen scales were constructed, representing the following sleep disorders and sleep-related problems: "insomnia", "psychiatric sleep disorder", "periodic limb movements", "sleep apnea", "excessive daytime sleepiness", "cataplexy", "sleep paralysis", "daytime dysfunction", "hypnagogic hallucinations/dreaming", "sexual/social dissatisfaction", "restless sleep", "negative conditioning" and "automatic behavior". Linear mixed model analyses were performed to study differences between the groups for the different SDQ scales over time.

Results: At baseline, there were no significant differences between the three therapy groups in the symptoms of these sleep disorders and sleep-related problems (F = 1.947–0.015; P = 0.153–0.985). The MAD group showed significant improvements in symptoms over time corresponding with "insomnia", "psychiatric sleep disorder", "periodic limb movements", "sleep apnea", "excessive daytime sleepiness", "sleep paralysis", "daytime disfunctioning", "hypnagogic hallucinations/dreaming", "restless sleep", "negative conditioning" and "automatic behavior" (F = 29.82–6.86, P = 0.000–0.014). These improvements in symptoms were, however, not significantly different from the improvements in symptoms observed in the nCPAP and placebo groups (P = 0.082–0.949).

Conclusion: There is no significant difference between MAD and nCPAP in their beneficial effects on symptoms of common sleep disorders and sleep-related problems in mild and moderate OSA patients. These beneficial effects may be a result of the time course and/or of placebo effects.

POSTER #004

WITHDRAWN

POSTER # 005

Halitosis and Obstructive Sleep Apnea Have Improved by Lip Muscle Training

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Introduction: In recent years, patients are increasingly complaining of dry mouth and halitosis, as well as snoring and obstructive sleep apnea (OSA), all of which are problems associated with mouth breathing. Despite the common thread, these conditions are often treated separately and there are few reports in the literature. We herein report a case of a patient who complained of halitosis and snoring, and whose symptoms were improved with lip muscle training.

Methods: The patient is Forty-year-old woman whose chief complaint is halitosis. The patient visited the Department of Comprehensive Clinical Dentistry, Nihon University School of Dentistry at Matsudo hospital in May 2012 for treatment of moderate halitosis following a halitosis test. The patient underwent periodontal treatment for one year according to hospital procedures, after which second halitosis test was given in July 2013. The results showed some improvement in, but no change in unpleasant subjective symptoms. The patient then mentioned that she snored. A simplified sleep test (SAS-2100, Teijin, Tokyo Japan) recorded a Respiratory Disturbance Index (RDI) of 8.2 times/hour, and the patient was diagnosed with mild OSA. The patient was treated with a mandibular advancement device (MAD) and an M-Patakara (PTR, Patakara Co., Ltd., Tokyo, Japan) was used for lip muscle training. PTR is made from flexible plastic and rubber, the resilience of which directly conditions the oral muscles to increase strength. In accordance with the supplied instructions for the use of M-Patakara®, patient underwent this training at the clinic and/or home for 5 minutes four times a day, every day, for 2 months. After several days of wearing the MAD, the patient complained of soreness in her temporomandibular joints. She discontinued using the MAD, and only continued treatment with the PTR. Two months of PTR use resulted in an increase in lip closure force, a reduction in RDI to 3.2 times/hour, and a decrease

in foul odor to a low threshold that the patient could scarcely detect.

Results: Prolonged chronic mouth breathing can reportedly lead to weakening of the orbicularis oris muscles and changes in tongue position. Moreover, mouth breathing may trigger halitosis, snoring and OSA. Through continued lip muscle training, the above patient no longer experienced halitosis upon awakening and her sleeping improved. These results suggest that there is a strong connection between halitosis and OSA via mouth breathing. We plan to conduct further studies on this relationship.

Conclusion: Lip muscle training increased lip closure force. And also, lip muscle training improved halitosis and RDI during sleep.

POSTER #006

Elevated Risk for Obstructive Sleep Apnea Predicts Temporomandibular Disorder Independently of Sleep Bruxism and Awake Bruxism

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Introduction: Temporomandibular disorder (TMD) is a musculoskeletal disorder characterized by persistent pain in the temporomandibular joint, periauricular region, or the head and neck muscles. Elevated risk for obstructive sleep apnea (OSA) predicts incident TMD; but whether this is a spurious association, confounded by sleep bruxism and awake bruxism, remains unclear. We hypothesized that baseline elevated risk for OSA, sleep bruxism and awake bruxism were each independent predictors of first-onset TMD incidence.

Methods: The prospective cohort, "Orofacial Pain, Prospective Evaluation and Risk Assessment" (OPPERA) study investigated risk factors for TMD incidence in people with no lifetime history of TMD. Between 2006 and 2008, men and women aged 18–44 years were recruited from four study sites: Chapel Hill, NC; Baltimore, MD; Buffalo, NY; and Gainesville, FL. At baseline, participants self-reported sleep bruxism and awake bruxism. To evaluate risk for OSA, they self-reported loud snoring, daytime tiredness, witnessed apnea, and hypertension. Participants with ≥ 2 of these OSA signs/symptoms, or a prior diagnosis of OSA, were classified as having elevated risk for OSA. A baseline clinical examination verified absence of TMD, according to modified Research Diagnostic Criteria. In up to 5.2 years of follow-up, participants completed TMD screening questionnaires every three months to monitor symptoms of first-onset TMD. Clinical re-examination determined TMD in the presence of: (1) ≥ 5 days/month of pain in the masticatory structures and (2) findings of arthralgia and/or myalgia. Risk for OSA, sleep and awake bruxism were modeled in multivariable Cox proportional hazards regression to estimate hazard ratios (HR) and 95% confidence limits (CL) for incident TMD, adjusting for potential confounding.

Results: Of a cohort of 2,660 adults, at baseline 5.8% of participants had elevated risk for OSA; 16.6% reported sleep bruxism at least 1–3 nights/month; and 14.7% reported awake bruxism at least some of the time. Over a median 2.8 years, 252 of the adults developed first-onset TMD. In univariate analysis, elevated risk for OSA, sleep bruxism, and awake bruxism were each significant individual predictors of TMD incidence. In multivariable analysis, the strength of association between OSA risk and TMD incidence was not attenuated with subsequent inclusion of sleep bruxism and awake bruxism. In the fully-adjusted model, incidence of first-onset TMD was 68% higher in participants at elevated risk for OSA (HR = 1.7, 95% CL: 1.1, 2.6) compared to those at low risk for OSA.

Conclusion: In OPPERA, elevated risk for OSA, reported sleep bruxism, and reported awake bruxism were independent risk factors for developing first-onset TMD.

POSTER #007

Prediction of the Therapeutic Efficacy of Oral Appliance Therapy Based on AHI and BMI

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Introduction: Indication for oral appliance therapy (OAT) is often expressed as a function of obstructive sleep apnea (OSA) severity. Classically OAT is indicated when the apnea/hypopnea index (AHI) shows mild (5 < AHI < 15) to moderate (15 < AHI < 30) OSA and/or in patients with severe (AHI > 30) OSA that refuse other treatment. In many patients OSA severity is also linked to their body mass index (BMI). The aim of the present study is to investigate the validity of preselecting patients on the basis of the baseline AHI and BMI with respect to therapy outcome defined as a decrease in AHI with a mandibular advancement device (OAm).

Materials and Methods: In a group of 89 patients (mean age 48 ± 10 years, M/F ratio 87%, BMI 27.7 ± 3.4 kg/m^2, AHI baseline 18.7 ± 11.9/h), OAT with a custom made titratable duoblock "Respident" (Belgium) OAm started in 75% of the maximal protrusion (MP). After 3 months a control PSG with $OAm_{75\%}$ (n = 68) was made. Success was defined as "Δ AHI ≥ 50% or AHI < 5/h".

Results: The $OAm_{75\%}$ significantly reduced the AHI to 12.3 ± 12.9/h (P < 0.001) while the changes in BMI did not exceed 1 kg/m^2. Plotting the AHI baseline versus BMI while defining an area delineated by AHI = 30/h and BMI = 30 kg/m^2 as the theoretical upper borders of patients treatable with OAm, the results show that n = 45 are within this box of which n = 21 (47%) were successfully treated. Outside the box are n = 23 of which n = 12 were successfully treated (52%). There is no significant difference in therapeutic outcome (P = 1.000) between the patients inside the "30–30 box" versus those situated outside. The same is true when plotting the change in AHI versus BMI.

Conclusion: Treatment success defined as "Δ AHI ≥ 50% or AHI < 5/h" in a group of patients with a custom-made duoblock

titratable oral appliance in 75% of the maximal protrusion, cannot be predicted on the basis of AHI baseline and BMI.

POSTER# 008

Effect of Titration on the Therapeutic Efficacy of Mandibular Advancement Therapy

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Introduction: Titratable oral appliance therapy (OAT) is generally started in an arbitrary mandibular protrusion. Therefore, additional protrusion or "titration" is required to optimize therapeutic outcome. More protrusion is however not always associated with a corresponding reduction in sleep apnea severity and could lead to increased side-effects. The aim of this study is to investigate whether titration will yield to a higher therapeutic efficacy in terms of an additional decrease in apnea-hypopnea index (AHI) in patients that started OAT in 75% of maximal protrusion (MP).

Methods: This study is an extension to the prospective clinical trial 'Predicting therapeutic outcome of mandibular advancement device treatment in obstructive sleep apnea (PROMAD)'. In the PROMAD protocol, 100 patients with obstructive sleep apnea (OSA) are included and started OAT at 75% of MP. In patients with a residual AHI > 5/h on a full night polysomnography (PSG) in the 75% of MP, the OAT was adjusted to 90% of MP with constant vertical dimension. This 90% position is a weighted compromise between efficacy and side-effects. After an habituation period but within 2 months after the PSG with OAT, a PSG was performed to assess the efficacy of the 90% position.

Results: Fifty-two OSA patients were included in this study. In 17 out of 52 patients (33%), the 75% position yielded an AHI < 5/h. The remaining 35 patients had an AHI > 5/h under OAT in 75% of MP and gave informed consent to adjust the OAT to the 90% of MP. In this group, the AHI decreased significantly from 22.6 ± 14.2/h at baseline, to 17.6 ± 14.6/h in the 75% MP ($P < 0.05$). The AHI further decreased significantly to 12.8 ± 8.6 in the 90% MP ($P < 0.05$). Nineteen patients (54%) showed a lower AHI in the 90% MP when compared to the 75% MP, whereas in 16 patients (46%) the AHI was higher in the 90% MP when compared to the 75% MP. In 6 patients (17%) the 90% MP resulted in AHI < 5/h.

Conclusion: Additional titration from 75% to 90% MP in patients who were not completely treated, an increased therapeutic efficacy could be achieved in 54% of the patients. In 17% of patients, the 90% MP resulted in AHI < 5/h.

POSTER 009

The Prospective Power of Drug-Induced Sedation Endoscopy in Predicting Therapeutic Outcome in Obstructive Sleep Apnea Patients Treated with Oral Appliance Therapy in a Fixed Mandibular Protrusion

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Introduction: There is a high need for the prospective identification of favorable candidates for oral appliance therapy in the treatment of obstructive sleep apnea (OSA). The objective of this prospective observational study was to evaluate the role of drug-induced sedation endoscopy (DISE) baseline findings in the prediction of treatment outcome in terms of treatment response and deterioration with a mandibular advancement type of oral appliance (OAm).

Methods: One hundred OSA patients were included in the study (83% male; age, 47.4 ± 11.5 years; body mass index (BMI), 26.9 ± 3.3 kg/m^2; apnea/hypopnea-index (AHI) at inclusion, 21.0 ± 11.2 events/hour sleep) whereafter a new baseline (BL) polysomnography (PSG) was obtained. They started OAm therapy in a fixed protrusion of 75% of the maximal mandibular protrusion. 67 out of 100 patients underwent a DISE as well as a PSG with OAm in that fixed protrusion. Statistical analysis was performed to evaluate the correlation between DISE findings and treatment outcome. Treatment success was defined as a decrease in AHI by PSG of 50% or more with OAm as compared to BL PSG or AHI with OAm < 5/h; whereas deterioration was defined as an increase in AHI with OAm when compared to BL PSG.

Results: Overall, thirty-one patients (46%) were successfully treated with the OAm in the fixed 75% protrusion. Statistical analysis with correction for the confounding factors BMI and AHI at BL, revealed that hypopharyngeal collapse during BL DISE is a negative predictor for success with an odds ratio (OR) of 0.25 (95% confidence interval (CI): 0.08–0.78, $P = 0.0165$). In addition, a complete concentric collapse (CCC) at the level of the palate was found to be associated with a higher risk for deterioration with an OR of 4.56 (95% CI 1.21–17.16, $P = 0.0250$). In 30 out of the 67 patients, there was no hypopharyngeal or palatal CCC during BL DISE. The success rate in those 30 patients is 60%.

Conclusion: DISE needs to be recommended as a patient selection tool for OAm therapy to treat OSA. The study shows that hypopharyngeal collapse during BL DISE is a negative predictor for treatment success and that a palatal complete concentric collapse predicts deterioration with OAm therapy.

POSTER #010

Longitudinal Survey of Mandibular Advancement Splint (MAS) Usage, Adherence, Side Effects and Interplay with Continuous Positive Airway Pressure (CPAP) Therapy: An Australian Story

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Introduction: Although CPAP remains the gold standard treatment for obstructive sleep apnea (OSA), many patients use alternative therapies such as MAS either alone or in combination. However, little is known about how patients use these 2 treatments. We surveyed Australian patients regarding this, their experience with MAS side effects and their adherence.

Method: A questionnaire was sent using both mail and email to 1,460 patients who had used MAS for the management of OSA or snoring.

Results: Thirty-three percent responded via mail and 25% via email (total 403 respondents for a total response rate of 28%). Median MAS usage was 1.6 +/- 1.5 years. Eighty-two percent of respondents used the device for 6 hours or more per night, 2.5% used it for 4–6 hours/night and 5% stated usage was variable. Fifty-nine percent used MAS as a first-line OSA therapy with 6% switching to CPAP. Thirty-five percent had had a previous trial of CPAP and 85% of these switched to regular MAS usage.

In keeping with accepted MAS guidelines, the device was predominantly used for mild to moderate OSA (71.3%). Other cases were: severe OSA in 21.5%, primary snoring in 0.6% and 6.6% not specified. Eighty-nine percent of patients felt the MAS was comfortable and improved sleep quality. Within this group, 79% reported improvement or resolution of snoring.

Regarding adverse events, 24.8% had minor side effects (e.g. transient temporomandibular joint discomfort, sore muscles, dry mouth) and 1.4 % had major adverse events (e.g. orthodontic side effects). Overall, 7.7% felt MAS was uncomfortable and 19 patients ceased MAS due to side effects. Sixty-one percent felt that MAS should be applied to a larger portion of the population as an effective therapy for OSA/snoring.

Thirteen percent of patients used the combination of MAS and CPAP (e.g. MAS therapy for travel and CPAP for home). An interesting observation was that 19% of these reported simultaneous CPAP and MAS therapy on a nightly basis.

Conclusion: This Australian study has found that MAS is used largely in mild to moderate OSA patients. Tolerance, usage and side effects were generally acceptable. A proportion of MAS patients also used CPAP, occasionally simultaneously.

POSTER #011

Three-Dimensional Analysis of the Oropharyngeal Airways in Cleft and Non-Cleft Patients Before and After Maxillary Expansion

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Introduction: The aim of this prospective study was to assess and compare the oropharyngeal airway dimensions in cleft and non-cleft lip and palate growing patients with maxillary constriction, before and after rapid maxillary expansion (RME).

Methods: The sample comprised 63 patients (mean age = 10.3 years), 30 cleft and 33 non-cleft individuals. Cone-beam computed tomography (CBCT) scans were taken to measure the oropharyngeal airway differences in terms of volume, axial cross-sectional areas, and anteroposterior and transverse widths before and after RME. Shapiro-Wilk normality test and Generalized Estimating Equations (GEE) with Bonferroni adjustment were used. The intrarater repeatability was calculated with intraclass correlation coefficient (ICC).

Results: The oropharyngeal airway dimensions were not significantly different when cleft and non-cleft patients were compared before the treatment. After RME, the total airway volume and the upper cross-sectional area were significantly increased in cleft patients ($P = 0.007$ and $P = 0.002$, respectively). Non-cleft patients presented significant increases in the area and transverse measurements at the upper cross-sectional plane of oropharynx ($P = 0.043$ and $P = 0.005$, respectively). Also, in the minimal cross-sectional plane there was significant increase in the transverse width ($P = 0.020$), and significant decrease in the anteroposterior width ($P = 0.042$). However, non-cleft patients showed no significant changes in the airway volume.

Conclusion: There were no dimensional differences in the oropharynx between cleft and non-cleft patients before the treatment. RME increased the airway volume, and it was significant in cleft patients. Non-cleft subjects presented increases in the transverse widths at upper limit and minimal cross sectional planes of oropharynx after RME.

POSTER #012

Impact of a Custom-Made Mandibular Repositioning Device on Blood Pressure in Obstructive Sleep Apnea Patients Noncompliant with Continuous Positive Airway Pressure

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Introduction: Guidelines recommend mandibular repositioning devices (MRDs) as second-line therapy for obstructive sleep apnea (OSA) patients noncompliant with continuous positive airway pressure (CPAP). The prevalence of arterial hypertension (HTN) is high in patients with OSA (OSA) pts and MRD therapy may improve blood pressure (BP).

ORCADES, a French prospective multicenter cohort study, is evaluating the clinical benefits of a custom-made MRD over 5 years in OSA pts who refused or did not tolerate CPAP. Interim 3-month (efficacy) and 9-month (tolerability) follow-up data are presented.

Methods: Sleep data, OSA symptoms, BP, quality of life, side effects and MRD compliance were evaluated in OSA pts fitted with a CAD/CAM MRD (Narval CC™). Treatment success was defined as a ≥ 50% decrease from baseline in the apnea-hypopnea index (AHI) and complete response was defined as an AHI of < 10/h. HTN was defined as office systolic (SBP) and/or diastolic BP (DBP) of ≥ 140 and ≥ 90 mmHg, respectively.

Results: 299 OSA patients treated with MRD were analyzed: 222 (74%) without HTN (non-HTN; SBP 122 ± 9 mmHg, DBP 74 ± 8 mmHg) and 77 (26%) with HTN (SBP 140 ± 8 mmHg, DBP 89 ± 8 mmHg). Sex ratio (75% male), age (53 ± 11y) and baseline AHI (29 ± 15/h) were similar in both groups. In the HTN group, body mass index, neck and waist circumferences were higher and nadir SpO_2 was lower.

MRD treatment success rate and mean AHI reduction were greater in the non-HTN vs. HTN group: 83.8% vs. 65.7%, P = 0.0012 and –19.7 ± 12.4 vs. –16.2 ± 12.3, P = 0.042. However, the complete response rate was similar in both groups (66%). Improvements in oxygen saturation, OSA symptoms and quality of life were similar in both groups. In the HTN group, MRD therapy significantly reduced SBP and DBP in HTN patients (by 7.6 ± 12.7 and 6.8 ± 10.2 mmHg; P < 0.0001 vs. baseline and P < 0.0001 vs. non-HTN group); BP was normalized in 59%. BP did not change significantly during MRD therapy in the non-HTN group. There was a significant correlation between DBP decrease and baseline AHI.

MRD compliance was high and similar in both groups (mean 6.6 h/night on mean 6.7 days/week). Half of treated patients from each group reported side effects, 14% of whom had severe events based on investigator assessment. Severe side effects included temporomandibular joint pain (4%, n = 13), dental or jaw pain (3.2%, n = 10), gum or periodontal pain (2.8%, n = 9) and gum irritation (1.5%, n = 5); 25 patients (8%) stopped treatment early due to side effects, mainly pain or irritation.

Conclusion: Custom-made CAD/CAM MRD is effective and has an acceptable tolerability profile in OSA patients noncompliant with CPAP. This treatment may also reduce BP in patients with HTN.

POSTER #013

Development of an Auto-Adjusting Mandibular Repositioning Device for In-Home Use

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Introduction: Although continuous positive airway pressure (CPAP) provides a more efficacious therapy than mandibular repositioning devices (MRDs) for the treatment of obstructive sleep-disordered breathing, CPAP is poorly tolerated by many patients. Recent studies suggest that both therapies are comparable in overall effectiveness due to greater patient preference and adherence to MRDs. However, acceptance of MRDs by the medical profession has been hindered by the long periods of time before the maximum efficacy of treatment is achieved and/or confirmed, and by the lack of objective means to assess nightly utilization. These barriers have been overcome for the in-home use of auto-adjusting CPAP, which adjusts the pressure required to minimize respiratory events while recording their occurrence and hours of utilization. The purpose of this ongoing project is to investigate the feasibility of an auto-adjusting MRD for in-home use, recognizing that the patency of the airway is improved by a different mechanism.

Methods: The concept of an auto-adjusting MRD consists of a commercially available MRD, fabricated with a MRD-specific pneumatic actuator (add-on) capable of changing the position of the jaw. A small flexible tube connects the actuator to a small syringe pump connected to a controller. The controller wirelessly receives signals from respiratory sounds sampled from the add-on in the patient's mouth, from a digital pulse oximeter, and from a body position sensor. Changes in jaw position can be specified in response to respiratory related signals after short (a few consecutive breaths) or longer (a few consecutive nights) periods of time.

In pilot testing, a pneumatic actuator was designed and constructed for a simple prefabricated device, the MyTAP appliance (Airway Management, Inc.). Two different iterations made of a biocompatible polymer were tested, measuring 9.62 cm^3 and 16.63 cm^3 and weighting 4.52 g and 10.56 g, respectively. To verify their performance both devices were tested on the same male adult, being awake and resting in supine position. His maximum retrusion and protrusion were 5 mm and 9 mm from the incisor edge-to-edge position. The jaw displacement was measured starting at the edge-to-edge position and compared against the air pressure that was required to advance the jaw.

Results: The device with the smallest form factor achieved 4 mm of jaw protrusion at 10 psi and a maximum of 8 mm at a pressure of 24 psi, while the larger device achieved 4.5 mm of jaw protrusion at 2.8 psi and 9 mm at 5.26 psi, reaching the maximum protrusion limit of the subject.

Conclusion: A low-cost, minimally intrusive pneumatic actuator provides an effective means to produce linear horizontal changes in jaw position as part of an auto-adjusting MRD.

POSTER #014

Dentofacial Characteristics of Children Suspected of Obstructive Sleep Apnea

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Introduction: Obstructive sleep apnea (OSA) in children is a common and serious disease effecting 1–5% of the population. Potential causes of OSA in children include adenotonsillar hypertrophy, obesity, neuromuscular disease and craniofacial abnormalities. The orthodontic correction of certain malocclusions, namely posterior crossbite and mandibular retrusion have been shown to be effective at ameliorating OSA symptoms. However it is currently unknown to what extent these forms of orthodontic treatment may be suitable in patients presenting to a tertiary care center for assessment and treatment of suspected OSA. The aim of this study is to report the incidence of malocclusion, and therefore indications for orthodontic treatment, of a population of children with suspected OSA.

Methods: Data collection consisted of a retrospective chart review of 110 patients between the ages of 5–10 referred to the Otolaryngology clinic at BC Children's Hospital between June 2012 and August 2014. All patients underwent a full clinical assessment by the attending otolaryngologist and orthodontist. The patient record provided comprehensive information regarding the patient history and soft tissues, as well as dentofacial features. Characteristics related to specific indications for early orthodontic intervention were recorded, including history of mouth breathing, tonsillar size, anterior crossbite, posterior crossbite, excess overjet and overbite. The Clinical Research Ethics Board of the University of British Columbia approved this study #H14-01596.

Results: The average patient age was 6.79 years. The parents of 47.3% of the patients reported a history of mouth breathing, while 57.5% of the patients presented with either Grade 3 or 4 tonsils on the Brodsky Grading scale. In terms of maxillary constriction, 13.6% of patients had a posterior crossbite, while 4.5% of patients had anterior crossbite. An increase overjet greater than 7mm was reported in 3.7% of patients, and 9.3% of patients presented with an overbite of more than 90%.

Conclusion: Maxillary expansion and mandibular advancement were indicated in 14% and 4% of the sample, respectively.

POSTER #015

Three-Year Effect of Oral Appliance Use on Mandibular Position in Patients with Obstructive Sleep Apnea

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Introduction: In individuals with obstructive sleep apnea (OSA) who use mandibular advancing oral appliances, the occlusal contact area is smaller in the morning than in the evening because of a bite change associated with mandibular protrusion during night. Considering that patients are encouraged to use an appliance daily, we hypothesized that the use of an oral appliance for several years could affect the position of the mandible in OSA patients.

Methods: This study was conducted in accordance with the amended Declaration of Helsinki. Patients who received their oral appliances from October 2000 to August 2008 after a diagnosis of OSA based on polysomnography were recruited. At their first visit to the dental clinic, patients agreed that their data could be used for research and provided their written consent for the anonymous use of their data. When a construction bite was registered to permit manufacture of the initial (i.e., stage 1) and follow-up (i.e., stage 2) monobloc oral appliances, resting mandibular position (RE) and maximum mandibular advancement position (MAX) were both recorded with a George Gauge. The absolute range of the maximum mandibular advancement in mm was then calculated as MAX-RE. Paired t-tests were used to compare the differences in each parameter between stage 1 and stage 2.

Results: The average duration of use of the initial oral appliance was 3 years and 5 months in 77 OSA patients. There were significant differences in RE (-5.8 ± 1.9 *vs* -4.8 ± 2.3 mm, $P < 0.01$) and MAX (6.3 ± 2.2 *vs* 7.8 ± 2.4 mm, $P < 0.01$) between the two stages. There was a significant change in MAX-RE from 12.1 ± 1.7 to 12.6 ± 1.6 mm ($P < 0.01$), with an average difference of 0.61 ± 1.5 mm. Moreover, a significant positive correlation was observed between the duration of initial oral appliance use and MAX-RE ($r = 0.27$, $P < 0.05$).

Conclusion: These findings suggest that the use of an oral appliance for 3 years can alter the mandibular position, which is associated with a greater change in the absolute range of maximum mandibular protrusion in patients who have used an oral appliance for longer. Since the treatment of OSA is a lifelong process, potential adverse effects should be minimized. We conclude that routine approaches to accelerate the repositioning of the mandible to the normal position, such as the use of jaw exercises in the morning, need to be more strongly emphasized in oral appliance therapy for OSA.

POSTER # 016

Innovative Technique for the Fabrication of the Custom Face Mask for Hybrid Therapy

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Introduction: The development of the TAP-PAP™ CM (Custom Mask) has changed the landscape of the treatment of OSA. The CM (Keith Thornton DDS inventor, FDA cleared and manufacture by Airway Management) is a custom CPAP face mask that is fabricated from the impression of the face. This mask is then connected to the post screwed into the TAP 3™ mechanism. This strapless CPAP face mask features efficient and stable CPAP interface with mandibular stabilization (Hybrid Therapy). The effectiveness and seal of the mask against the face is dependent on the accuracy of the face impression. Since observation is the beginning of science, the purpose of this study is to identify the type of impression that results in the most efficient seal of the CM.

Methods: A new technique of a two stage polyvinyl siloxane (PVS) face impression was accomplished on three patients. Preparation of the patient for this impression is the same for the one stage impression. A breathing tube is put over the post that is attached to the patients TAP 3™ and extruding out between the closed the lips. Then a piece of cotton roll is put into both nostrils allowing the border of the nares exposed for impression. Last, Vaseline is applied to the face. Stage one was a light body PVS applied with an impression syringe directly onto the face. Stage two was a medium body PVS applied to a molded thermoplastic perforated disk, then put onto the face over the stage one application. When set, it was pulled off and inspected for any defects.

Results: The impressions were superior to the single stage alginate or PVS impression. Frequent issues with single stage impressions included voids, compressed tissue, inadequate borders and a rushed experience due to setting time of the single stage. Retakes for both alginate and PVS are about 20% based on these authors extensive experience. These issues were all eliminated with the two stage technique. With the first stage being applied to the face via syringe, there was absolute control over all these issues. This technique afforded the time to calmly apply the material, which produced an extremely accurate impression of the face with one attempt, which resulted in a CM that fit accurately on the first insertion.

Conclusion: This study clearly demonstrates, that the two stage face impression technique for the fabrication of the Custom Mask is superior to previous techniques. It eliminates the issues of obtaining accurate face impressions that are inherent of the one stage impression technique. This two stage impression technique will not only reduce the time required for the impression and the delivery of the CM, but will also give a superior seal of the highest quality CPAP interface in our profession at this time.

POSTER #017

An Auto-Titrating Mandibular Positioner: Accuracy in Predicting Oral Appliance Therapy Outcome and Efficacious Mandibular Protrusion

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Introduction: We have developed an auto-titrating mandibular positioner for predicting oral appliance therapy (OAT) outcome and efficacious target protrusive position (ETPP) in obstructive sleep apnea (OSA). The present study evaluates the accuracy of the automated titrator when used unattended in the home.

Methods: Study participants (n = 124, mean AHI = 24.9 ± 13.0 hr^{-1}) were derived from 151 patients with OSA, of whom 9 discontinued participation, 14 are currently in progress, and 4 had inconclusive studies. The remaining 124 participants formed our study population. All participants received a two night unattended mandibular titration study at home The mandibular positioner comprised of temporary dental trays attached to a computer-controlled actuator, and during the titration study, apneas and hypopneas were automatically detected from respiratory airflow and oxyhemoglobin saturation. Study 1 involved continuous interaction between detected respiratory events and mandibular position. In Study 2, the positioner held the mandible at an ETPP predicted by Study 1, and further protruded the mandible when the AHI exceeded 10 hr^{-1}. Prospectively established prediction rules applied to the results of each titration study predicted OAT outcome, either predicted success (PS) or predicted failure (PF), and discrepant predictions were resolved by repeating Study 2. Participants classified PS were prospectively assigned a predicted ETPP, and participants classified PF were assigned a sham protrusive target (70% of full protrusion). All participants received a custom dental appliance (G2 Somnomed). Baseline and outcome AHI values were the mean of two nights of home sleep testing, and therapeutic success with OAT was defined as outcome AHI < 10 hr^{-1} & 50% of baseline AHI.

Results: The unattended auto-titration studies provided satisfactory results in almost all cases (inconclusive study rate: 3%). The overall therapeutic success rate was 73%. Using prospective prediction rules 83 participants were classified as PS and 41 as PF. Values for sensitivity/specificity and positive/negative predictive (P/NPV) were 0.82/0.76 and 0.90/0.61, respectively, with an overall incorrect prediction rate of 19%. A retrospective, classification decision tree analysis reduced this rate to 11% and provided values for sensitivity/specificity and P/NPV values of 0.93/0.77 and 0.91/0.82, respectively. Of the 75 PS participants who experienced therapeutic success, 71 responded at the predicted ETPP (PPV = 0.95). For the 75, the median relative protrusion at therapeutic success was 75% (range: 9–100%) and in 41% therapeutic success occurred at less than 70% of full protrusion.

Conclusion: The results of this prospective clinical trial show that the auto-titrating mandibular positioner is suitable for use

in the home and accurately predicts OAT outcome as well as an ETPP. The system may increase OAT efficacy and efficiency while avoiding excessive mandibular protrusion in some cases.

(This research was supported by grants from NRC-IRAP of Canada, Alberta Innovates-Technology Futures, and Zephyr Sleep Technologies.)

POSTER #018

Parallel Changes in the Frequency of Respiratory Events and Swallowing during Sleep in Obstructive Sleep Apnea Patients with and without a Mandibular Advancement Device

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Introduction: We have previously demonstrated that swallowing frequency during sleep increases with obstructive sleep apnea (OSA) severity in most OSA patients, and that these swallowing events predominately occur subsequent to respiratory events. The findings obtained in the cross-sectional cohort study leave open the possibility that respiratory event frequency may be a key determinant of swallowing frequency during sleep in OSA patients. To test this possibility, we carried out a split-night sleep study and investigated frequency changes in respiratory events and swallowing during sleep in OSA patients with and without a mandibular advancement device.

Methods: Ten patients with previously diagnosed OSA were prospectively and consecutively enrolled in a split-night sleep study for the follow-up of a titratable mandibular advancement device in a hospital sleep laboratory. During the split-night sleep study using standard video-polysomnography, the first half of the night was assigned to a diagnostic phase and the second half of the night was assigned to a mandibular advancement device therapy phase. Swallowing was evaluated with a piezoelectric sensor placed over the neck superior to the laryngeal prominence. A swallowing event was defined as simultaneous signals of an increased chin EMG activity, transient interruption of airflow and a transient elevation of the thyroid cartilage. The frequency of swallowing per hour of sleep was calculated in each phase. P values of < 0.05 were considered significant.

Results: Nine of the 10 OSA patients slept for more than 60 minutes in each phase (diagnostic phase, 118.6 ± 31.4 [mean ± SD] min; mandibular advancement device therapy phase, 213.0 ± 32.6 min) and the phases were compared. Eight of the 9 OSA patients exhibited parallel changes in the apnea hypopnea index (AHI) and swallowing frequency between the two phases. In 5 of the 8 patients, the AHI and swallowing frequency both decreased during the mandibular advancement device therapy phase compared to that of the diagnostic phase. In the remaining 3 of 8 patients, the AHI and swallowing frequency both increased during the mandibular advancement device therapy phase compared to that of the diagnostic phase. An increase in an AHI was significantly correlated with an increase in swallowing frequency between the two phases ($r_s = 0.85$, $P = 0.004$).

Conclusions: Respiratory event frequency, rather than the presence of a mandibular advancement device in place, can be a determinant of swallowing frequency during sleep in most OSA patients.

POSTER #019

Effects of Combined Maxillo-Mandibular Oral Appliance Therapy in Adults with Severe OSA

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Introduction: Mandibular repositioning devices (MRD) have long been deployed for the management of mild to moderate OSA, but there is less evidence on their efficacy in severe cases that have failed to comply with CPAP therapy. Biomimetic oral appliance therapy (BOAT) differs from conventional MRD therapy as it aims to correct the nasal airway through midfacial redevelopment in combination with mandibular repositioning, which aims to improve the oropharyngeal airway in adults. In this preliminary investigation, we tested the hypothesis that severe OSA can be addressed using combined maxillo-mandibular BOAT in adults.

Methods: In this pilot study, we included 7 consecutive adults aged > 21 yrs that had been diagnosed with severe OSA, following an overnight home sleep study that had been interpreted by a Medical physician. Each subject that participated in this study had failed to comply with CPAP therapy and was treated under medical supervision by a dentist with advanced training in dental sleep medicine. At each monthly follow-up visit, examination for progress and adjustments of the devices were performed to optimize their efficacy. The mean apnea-hypopnea index (AHI), respiratory disturbance index (RDI) and oxygen desaturation index (ODI) of the study sample was calculated prior to and after BOAT. The findings were subjected to statistical analysis, using paired t-tests.

Results: Prior to treatment the mean AHI of the study subjects was 45.2 ± 8; the mean RDI was 47.4 ± 8, and the ODI was 33.6 ± 9. A further follow home sleep study was done after approximately 9 mos. At this time, the AHI decreased significantly ($P < 0.001$) to a mean value of 19.5 ± 6 after BOAT, which represents a fall in the mean AHI of 57% for the study sample. The mean RDI fell to 23.7 ± 7.7 ($P < 0.001$), and the ODI was improved to 11.2 ± 1.9 ($P < 0.001$).

Conclusion: This pilot study suggests that combined maxillo-mandibular oral appliance therapy may be a useful method of managing severe cases of OSA in adults, and might represent an alternative to CPAP and MRD therapy. However, long-term follow up using a larger sample size is needed to reach more definitive conclusions on these preliminary findings.

POSTER #020

Effects of Neuromuscular Electrical Stimulation on the Masticatory Muscles and Physiologic Sleep Variables in Adults with Cerebral Palsy: A Novel Therapy Approach

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Introduction: Cerebral palsy (CP) is a term employed to define a group of non-progressive neuromotor disorders caused by damage to the immature or developing brain, with consequent limitations regarding movement and posture. CP may impair oral pharynx muscular tonus leading to a compromised mastication and to sleep disorders (e.g.: obstructive sleep apnea). The aim of the present study was evaluate the effects of NMES on the masticatory muscles and physiologic sleep variables in adults with CP using EMG and PSG. The hypothesis is the NMES will improve masticatory function and sleep variables.

Methods: 15 adults with CP underwent bilateral masseter and temporalis neuromuscular electrical stimulation (NMES) therapy and its effect over masticatory muscle and sleep variables were evaluated through electromyography (EMG) and polysomnography (PSG), respectively, prior and post 2 months of NMES therapy. EMG consisted of 3 tests in different position: rest, mouth opening and maximum clenching effort (MCE).

Results: The EMG values in the resting position were 100% higher prior to therapy for all muscles analyzed ($P < 0.05$); mean mouth opening rose from 38.0 ± 8.0 to 44.0 ± 10.0 cm ($P = 0.03$) and MCE was significantly only for right masseter, whereas other muscles exhibited improvements in comparison to baseline. PSG shown that AHI improved from 7.1/h to 1.7/h ($P < 0.05$), total sleep time improved from 185 min to 250 min ($P = 0.04$) and minimal SaO_2 improved from 83.6 ± 3.0 to 86.4 ± 4.0 ($P = 0.04$).

Conclusion: NMES performed over a two-month period led to an increase in the electrical activity of the masticatory muscles at rest, opening and during isometric contraction and improved sleep variables, including the elimination of sleep apneas events in CP patients.

http://dx.doi.org/10.15331/jdsm.4874

AADSM News and Updates

Reported by Ghizlane Aarab, DDS, PhD; Leila Chahine, DDS, Diplomate, ABDSM; Matthew Danchuk, DMD; Leslie C. Dort, DDS, Diplomate, ABDSM; David Schwartz, DDS, Diplomate, ABDSM

AADSM 24TH ANNUAL MEETING

Dr. Kathleen Bennett, President of the AADSM, welcomed members and attendees to the 24th Annual Meeting of the AADSM. The meeting began with the presentation of the AADSM awards. Frédéric Gagnadoux, MD, PhD received the Pierre Robin Academic Award; Dr. Sheri Katz, DDS received the Distinguished Service Award; and Dr. Gilles Lavigne, DMD, PhD was given the Honorary Membership Award for 2015.

Dr. Greg Essick, Chair of the AADSM Research Committee, presented the following abstract awards:

- Clinical Excellence Award – Shouresh Charkhandeh
- Clinical Research Award – Lilian Giannasi
- Clinical Research Award – Marijke Dieltjens
- Student Excellence Award – Elizabeth Kornegay
- Student Research Award – Fabiane Azeredo
- Student Research Award – Rita Brugarolas

Selected Meeting Highlights

Keynote Speaker: Impact of Opiates on Sleep and Addiction Risk: What Dentists Should Know
Gilles Lavigne, DMD, PhD

Dr. Lavigne discussed the chronic pain and opioid crisis. He reminded the audience that dentists are among the top prescribers of opioids. Acute pain needs to be managed but with caution. Dental providers may be the first to expose teenagers to opioids for pain after accidental injury, third molar surgery or orthognathic surgery. Dr. Lavigne cautioned against sending post-surgery patients home with large quantities of opioids.

At least 20% of the North American population experiences chronic pain and therefore those practicing dental sleep medicine will have a significant portion of their patients using opioids for pain. This situation is particularly relevant in North America where 80% of the world's opioid consumption occurs. Dental sleep medicine practitioners need to be aware of opioid use in their patients because opioids increase upper airway resistance and blunt other chemo-reflexes related to breathing. Good use of opioids is critical. There is a need to balance the right to pain relief and the possibility of misuse.

Nasal and Pharyngeal Surgery for OSA
Edward Weaver, MD

Dr. Weaver reviewed the literature on the use of surgery as an adjunct to CPAP therapy. There are to date no studies on the role of surgery as an adjunct to oral appliance therapy. He also addressed the role of surgery as salvage therapy. Although surgery may not be curative in terms of AHI reduction., AHI reduction has a poor correlation with quality of life and health effects. OSA is a progressive disease and surgical treatment may slow the progression. He emphasized that approaches to surgery should be minimally invasive, that functional obstructions should be addressed and approaches tailored to the individual's anatomy. Although useful as second line therapy surgery rarely cures OSA, poses risks and may introduce difficult recovery.

Challenging Case Reports

Dr. Michelle Cantwell presented a 56-year-old male with a history of hyperlipidemia, hypertension and gastroesophageal reflux disease. The patient reported having undergone orthognathic surgery to correct Class III malocclusion in 1998. There were no reported sleep problems or excessive daytime sleepiness prior to 1998. Following surgery the patient noted increasing fatigue, snoring and he underwent a diagnostic sleep study that indicated an AHI of 90 events/hour of sleep. In 2001, he underwent UPPP surgery with a residual AHI of 45 events/hour of sleep. In 2006, the patient initiated treatment with a mandibular advancement appliance. A repeat polysomnogram with device in place yielded an AHI of 6.2 events/hour of sleep. The patient was followed closely, had excellent homecare and his symptoms were managed well for five years. In 2012, the patient returned to his pulmonologist concerned that symptoms had returned. He was retested with his oral appliance in situ and his AHI had increased from 6.2 to 28.3 events/hour of sleep. His pulmonologist recommended CPAP but the patient refused. In 2013, a new appliance was made and calibrated. The patient changed pulmonary providers in early 2014, who suggested another sleep study to access the effectiveness. In February 2014, his PSG with oral appliance in situ yielded an AHI of 41.8 events/hour of sleep. Therefore, in April 2014, the patient was fitted with a Bi-level PAP therapy, with 16/12 cm H_2O with a residual AHI of 17 events/hour of sleep. The patient tried Bi-level PAP at home for one month, however, he could not tolerate it and came back to their prosthodontic office for re-evaluation. In May 2014, his oral appliance was calibrated further in office and a calibration home sleep study was completed during which the patient slept only on his side yielding an AHI of 6 events/hour of sleep. The patient's results were shared with his pulmonology team. However, in September 2014, the patient reported being unable to maintain positional change and was referred for surgical consultation. The patient has been assessed and is currently awaiting insurance preauthorization for hypoglossal nerve stimulation surgery. He is being monitored by his pulmonology team and is attempting to use positional therapy and an oral appliance until surgery is approved.

Dr. Ghizlane Aarab presented a 41-year-old male Treacher Collins syndrome patient with severe obstructive sleep apnea (OSA). Treacher Collins syndrome is an autosomal dominant congenital disorder characterized by craniofacial deformities. This patient complained about unrefreshing sleep, snoring, and daytime fatigue. Information about the general health status (BMI of 23.5 kg/m^2, hypertension, smoking, and alcohol intake), photographs of his face, intra-oral photos, a panthomogram, and the outcome of the baseline polysomnographic (PSG) recording (AHI = 63 events/hour of sleep) were shown during this presentation. The patient presented the following problems: 1. CPAP failure because of adherence problems 2. daytime and nighttime problems with breathing; 3. depressed mood with suicidal thoughts. The audience was challenged to answer the following questions: 1. What is the suspected etiology of OSA?; 2. Which additional diagnostic tests are needed?; 3. Which treatment options are available for this patient? After this challenge, the outcomes of the cone beam CT (CBCT) and of the drug induced sleep endoscopy (DISE) were shown. The CBCT showed the following risk factors of OSA: deviation of the nasal septum, retrognathic mandible, and a hypoplasia of the zygomatic complex. The DISE showed a complete collapse of the upper airway at the velo-pharynx and at the tongue base. The chin lift showed good clinical effect, therefore oral appliance therapy was suggested by the ENT physician. A mandibular advancement appliance (MAA) was placed and titrated in four visits based on subjective reports of the patient. The patient had an evaluation PSG with the MAA set at the 75% of the maximal protrusion in situ. The PSG showed that the MAA was not effective in lowering the AHI (62 events/hour of sleep), although the patient reported improvement in OSA symptoms. An maxilla- mandibular advancement with a double zygoma osteotomy was suggested to the patient. The patient refused this treatment, and he decided to have another try with CPAP.

Gizmos and Gadgets: Using Technology to Enhance the Care of Patients with Sleep Disorders
Dr. Neil Freedman, MD

Dr. Freeman reviewed some of the newest technologies that may be used in the field of sleep both by clinicians: now or in the future. He reviewed some of the features of ambulatory sleep testing devices commenting that some devices can allow the differentiation of central and obstructive events and others cannot. He commented that improvements in technology will expand the options for diagnosis and treatment but cautioned understanding of the limitations of devices to ensure they are used in appropriate populations. There is a lack of consistent training opportunities with the majority of ambulatory devices so scoring and interpretation beyond that given automatically can be challenging. The results and scoring from some devices will be compromised if patients on certain medications such as alpha blockers or have peripheral neuropathies. There are promising devices that may be useful for population based screening in the future. Most of the devices used today are most appropriate for those with a high pre-test probability of OSA.

Sleep Apnea's Contribution to the Stress Load and Mindfulness Based Stress Reduction
Mark Abramson, DDS

Dr. Abramson addressed the fact that humans have a multitude of stressors during the day that cause sympathetic activation leading to increase in BP, tearing of cellular walls and platelet thickening. As a reaction, Cortisol levels increase. This whole process is compounded by the fact that if you have OSA, this same sympathetic activation is occurring and of course is piggy backing onto the day time stressors. He is initiating programs at Stanford, whereby the physicians and students of the medical program are undergoing Mindfullness and Meditation training as a way to improve their behavior, their focus and performance. He had the audience perform a breathing exercise to show how breathing mindfully can improve our stress level immediately. It is these stresses that break down cells and cause cell death prematurely. Meditation can slow this rate down.

Dentofacial Consequences of CPAP
Hiroko Tsuda, DDS, PhD

Dr. Tsuda did a review of some research in both from Japan and at UBC in Vancouver. Normal Growth in children can be altered if SDB conditions become prevalent—such as adenotonsillary hypertrophy—and if left untreated can create midface deficiency and other orthodontic/orthopedic changes. First line treatment is considered Adenotonsillar removal. Unfortunately unresolved SDB in such patients can lead to long term chronic pediatric use of CPAP may also cause dental and orthopedic alterations including maxillary dental and skeletal retroclination and class III growth tendencies and maxillary midface hypoplasia and deficiency. In Adults edentulism is found to have a high correlation with increased AHI, and wearing of dentures does appear to help decrease AHI in most cases, but 44.6% of patients complained of dry mouth since beginning CPAP therapy in a 744 patient questionnaire of patients on CPAP more than 4 years. Many of these patients were aware of OAT but had a high incidence of dental neglect and may not be good candidates for OAT without proper dental treatment and intervention.

Trends in Sleep Medicine
Nathaniel Watson, MD, MS

Dr. Watson discussed some of the up and coming technologies for assessing sleep. He cautioned that many of the devices aimed at consumers are marketed as entertainment devices and therefore usually do not have validation studies. Some of the smartphone apps are promising but there are legal and social issues related to storage, access to and use of the data collected. Giving patients and their health care providers more information will allow for customized advice and treatment.

Dr. Watson reviewed the findings of the recent consensus conference on sleep duration for adults. Adults should sleep 7 or more hours to promote optimal health. There is good evidence that 6 hours or less is not healthy. There is uncertainty whether 9 hours or more is unhealthy. In certain situation, such as recovery from a period of restricted sleep or recovery from illness, that more than 9 hours may be beneficial but uncertainty over whether more that 9 hours on a regular basis is health.

AADSM 2015 EDUCATIONAL CALENDAR OF EVENTS

Upcoming 2015 Education

August 11–October 20
Fall Study Club Program
live, web-based seminars

September 19
Practical Demonstration Course
Darien, IL – AADSM National Office

November 7–8
Advanced Dental Sleep Medicine Course
Orlando, FL

Essentials of Dental Sleep Medicine Course
Orlando, FL

December 5
Practical Demonstration Course
Darien, IL – AADSM National Office