Obstructive sleep apnea (OSA) is the periodic reduction (hypopnea) or cessation (apnea) of airflow due to narrowing of the upper airway during sleep, often accompanied by hypoxemia and sleep disturbance.1 The prevalence of OSA is estimated to be between 2% and 25% in the general population. OSA is linked to hypertension, ischemic heart disease, stroke, premature death, and motor vehicle crash.2-7

Oxygen desaturation is an immediate consequence of obstructive sleep apnea. Intermittent hypoxemia increases sympathetic activity and norepinephrine levels and leads to hypertension.8,9 It has also been associated with an increased risk of diabetes.10 Indeed, most of the sequelae of obstructive sleep apnea are more strongly linked to the degree and duration of oxygen desaturation than to the numbers of apneas and hypopneas or disruptions in sleep architecture.11 The resolution of nocturnal intermittent hypoxemia associated with sleep apnea is a major goal of the treatment of patients with obstructive sleep apnea.

Many treatment approaches have been employed for the treatment of moderate to severe OSA, but CPAP is the treatment of choice and has been widely prescribed.12,13 In placebo-controlled and uncontrolled studies, CPAP has been shown to reduce apnea-hypopnea index (AHI) and to improve hypoxemia associated with respiratory events during sleep.14,15 CPAP adherence has been reported to be as low as 50%, at least in part because it is a burdensome treatment.16

Oxygen administration has been used as an alternative treatment in patients with obstructive sleep apnea (OSA) who do not adhere to continuous positive airway pressure (CPAP) in order to reduce the deleterious effects of intermittent hypoxemia during sleep. This systematic review aims to investigate the effects of O2 therapy on patients with OSA.

**Background**: Hypoxemia is an immediate consequence of obstructive sleep apnea. Oxygen (O2) administration has been used as an alternative treatment in patients with obstructive sleep apnea (OSA) who do not adhere to continuous positive airway pressure (CPAP) in order to reduce the deleterious effects of intermittent hypoxemia during sleep. This systematic review aims to investigate the effects of O2 therapy on patients with OSA.

**Method**: We conducted a systematic search of the databases Medline, Embase, Cochrane Central Register of Controlled Trials (1st Quarter 2011), Cochrane Database of Systematic Reviews (from 1950 to February 2011). Our search strategy yielded 4,793 citations. Irrelevant papers were excluded by title and abstract review, leaving 105 manuscripts. We reviewed all prospective studies that included: (1) a target population with obstructive sleep apnea, (2) O2 therapy and/or CPAP as a study intervention, (3) the effects of O2 on the apnea-hypopnea index (AHI), nocturnal hypoxemia, or apnea duration.

**Results**: We identified 14 studies including a total of 359 patients. Nine studies were of single cohort design, while 5 studies were randomized control trials with 3 groups (CPAP, oxygen, and placebo/sham CPAP). When CPAP was compared to O2 therapy, all but one showed a significant improvement in AHI. Ten studies demonstrated that O2 therapy improved oxygen saturation vs. placebo. However, the average duration of apnea and hypopnea episodes were longer in patients receiving O2 therapy than those receiving placebo.

**Conclusion**: This review shows that O2 therapy significantly improves oxygen saturation in patients with OSA. However, it may also increase the duration of apnea-hypopnea events.

**Keywords**: OSA, CPAP, oxygen therapy

**Citation**: Mehta V; Vasu TS; Phillips B; Chung F. Obstructive sleep apnea and oxygen therapy: a systematic review of the literature and meta-analysis. J Clin Sleep Med 2013;9(3):271-279.

**METHODS**

For purposes of this analysis, the target population consisted of adult humans with a diagnosis of obstructive sleep apnea defined as an AHI > 5 events per hour. The diagnosis of OSA was made using polysomnography (PSG). The study intervention included...
either the CPAP and oxygen therapy or oxygen therapy compared with the placebo. Outcomes of interest included the effects on AHI, nocturnal hypoxemia, apnea duration, and arousal index.

**Literature Search**

The literature search was performed according to the PRISMA (Preferred Reporting Items for Systematic reviews and meta-analysis) guidelines. The databases Medline, Embase, Cochrane Central Register of Controlled Trials (1st Quarter 2011), Cochrane Database of Systematic Reviews (from 1950 to Feb 2011) were thoroughly searched to include all available evidence for the systematic review. We developed and executed the search strategy with the help of an expert librarian familiar with the literature search protocol of the Cochrane Collaboration. The following target population keywords were used for the literature search: “obstructive sleep apnea,” “obstructive sleep apnea syndrome,” “obstructive sleep apnea-hypopnea syndrome,” “sleep disordered breathing,” “obesity hypoventilation syndrome” and “apnea-hypopnea,” “sleep apnea syndrome and apnea.” The target intervention keywords used were “oxygen”, “oxygen therapy,” “oxygen inhalational therapy,” “CPAP,” “positive airway pressure,” and “continuous positive airway pressure.” The results of the target population were combined with the target intervention keywords (using an “and”). Studies focusing on central sleep apnea were excluded by including “NOT central sleep apnea” in the search strategy. The search strategy was limited to English language abstracts and adult human population. Duplicate records, if any were removed from the final search result. We also reviewed the reference lists of relevant articles to retrieve potentially relevant articles.

1. Medline (Ovid SP) (1948 to Feb 2011)
2. EMBASE (1980 to Feb 2011)
3. Cochrane Database of Systematic Reviews (1st quarter 2011)
4. Cochrane Central Controlled Trials Registry (1st quarter 2011)

The databases of the Cochrane Library were used to confirm the completeness of the search. The time period searched was 1948 to 2011.

**Study Selection**

The search results were evaluated by two independent reviewers (VM, TSV). First, irrelevant papers were excluded by reviewing the title of the records. Next, the abstract and/or full text articles of the remaining papers were retrieved and carefully evaluated to determine if they met the eligibility criteria.

All prospective studies, including randomized and non-randomized placebo controlled trials were included if they reported the effects of CPAP treatment or oxygen therapy on AHI, oxygen saturation, apnea duration, and arousal index in patients with OSA. Studies not reporting at least one of these outcomes were excluded. All observational studies were graded for strength of evidence according to the Oxford level of evidence. We used the Cochrane risk of bias tool to assess the risk of bias for 6 randomized controlled trials (Table 1).

**Data Extraction**

Data extraction was completed by two reviewers (VM, TSV) and validated by the senior author (FC). Various data extracted from these studies included the type of study, level of evidence, number of patients receiving the study intervention, type of study intervention, duration and effects of intervention on AHI, SpO2, arousal index, and apnea duration. We divided the studies into 2 groups: the first group included studies which used CPAP and O2 treatment; the second group included studies which used only O2 therapy as an intervention. The methodological qualities of the included studies were independently evaluated by the first author (VM), if any doubt the senior author was consulted (FC). Individual authors were contacted via emails for the details of the results.

**Statistical Analysis**

We performed the meta-analyses by using fixed-effects model if no heterogeneity was present. In order to assess the heterogeneity between studies, we used χ2 tests and estimated the I² statistic. We considered the heterogeneity to be present if the p value on the χ2 test was < 0.05. In the presence of heterogeneity, we pooled the results by using random-effects (DarSemonian and Laird method) model. The standardized mean difference was used to pool continuous variables that used different scales. We performed separate random-effects meta-analyses among randomized controlled studies comparing CPAP, placebo CPAP, and oxygen. We did not correct for multiple comparisons.

**RESULTS**

The Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines were followed for the description of the search strategy. Our search strategy yielded 4,793 citations (Figure 1). In the first session of screening, most studies were eliminated based on the predetermined eligibility criteria, leaving 105 articles. In the second session, 105 articles were evaluated and 14 articles were identified as...
meeting the inclusion criteria, with subsequent exclusion of 91 articles. Articles were excluded for the following reasons: Non-pertinent papers—excluded by abstract/full-text review (n = 64), O₂ therapy in pediatric OSA (n = 11), reviews papers (n = 10), correspondence (n = 4), and case reports (n = 2).

Study Characteristics

Tables 2 and 3 summarize study characteristics included in the systematic review. There were 6 studies, that used a randomized control design with 3 groups, each group being assigned to CPAP, placebo CPAP, or O₂ to evaluate the effects of CPAP and O₂ on AHI, O₂ saturation, and arousal indices. Eight studies used a single cohort in which the outcome was measured in the same study population before and after the study intervention. All of these observational studies compared the effects of room air with O₂ on mean oxyhemoglobin saturation, sleep disordered breathing (SDB) events, and SDB event duration. These 8 studies were graded according to Oxford level of evidence and had a 2b level of evidence. We could not pool the results from the study by Block et al. because the authors did not provide the standard deviation for the outcome of interests.

Patient Characteristics

Table 2 represents a group of patients who received CPAP and O₂ intervention versus placebo CPAP. Table 3 represents a group of patients who received O₂ intervention compared with control (air). A total of 359 patients were included in the 14 studies. All the patients had a diagnosis of OSA confirmed by in-laboratory polysomnography. The inclusion criteria of the patients differed among the studies selected for the review. Two studies used AHI > 5; 5 studies used AHI > 15; one study used SDB event > 50/h, and one study used RDI > 20 for OSA patient selection. Four studies selected patients with a confirmed diagnosis of OSA following overnight PSG with no description of any specific AHI criteria. Most of the patients were male, accounting for 89% of the study population. All the patients in the reported studies had moderate to severe OSA with AHI ranging from 20.5 ± 5 to 88.2 ± 27. The duration of the study intervention across the different studies was in the range of 1 night to 3 months.

Effects on Oxygenation, Respiratory Events, and Sleepiness

Table 2 summarizes the effects of the different treatment modalities on AHI, SpO₂ and arousal events studied by 6 RCTs. The respiratory disturbances occurring during the nighttime in OSA patients were measured using AHI, respiratory disturbance index (RDI), or SDB events. When CPAP was compared with O₂, CPAP was significantly more effective in reducing AHI, while O₂ was shown to be more effective in elevating the mean SpO₂ and mean nadir SpO₂ during hypoxemic events. Both CPAP and O₂ improved the oxygenation as compared to placebo (sham) CPAP; this effect was statistically significant (p < 0.05). Four studies showed that CPAP versus O₂ therapy was more effective in improving the arousal events/total arousal index, but we could not pool the arousal events for the meta-analysis because of insufficient data.

The effects of CPAP and oxygen supplementation on the daytime somnolence was evaluated by 2 studies. In one study, nasal CPAP was more effective in improving objectively measured daytime sleepiness than oxygen. This effect was apparent due to the significant efficacy of CPAP in lengthening the multiple sleep latency test (MSLT) time compared to baseline. Similarly, another study showed the effectiveness of CPAP in reducing Epworth Sleepiness Scale score; however, it was not statistically different from placebo-CPAP or supplemental oxygen.

Effects on Systemic Blood Pressure

Three studies showed the treatment outcome on systemic blood pressure in patients treated with CPAP, oxygen, and placebo-CPAP. Two studies showed that CPAP effectively reduced both the systolic as well as the diastolic blood pressure as compared to oxygen (p < 0.05). In one study, CPAP and oxygen both had the effects in lowering the systolic blood pressure as compared to diastolic blood pressure; however, the changes were not statistically significant. The effects of O₂ therapy on the oxygen saturation and SDB events are summarized in Table 3. Seven studies showed that oxygen therapy was effective in improving the oxygenation as compared to air (control) in OSA patients. The SDB events include snoring, sleep-related hypoxemia, and daytime sleepiness.
showed a decreasing trend in the number of events when the patients received \( \text{O}_2 \) therapy after breathing room air. One study demonstrated an improved cardiovascular status in OSA patients following oxygen enrichment night.\(^{34} \) Similarly, another study showed an improvement in daytime somnolence in patients receiving oxygen therapy.\(^{35} \)

Meta-Analysis of Randomized Controlled Trials

**Effects on Apnea Hypopnea Index (Figure 2)**

A pooled analysis of 5 randomized controlled trials demonstrated that the use of therapeutic CPAP lead to a statistically significant reduction in the AHI versus nocturnal administration of oxygen (SMD -3.37, 95% CI -4.79 to -1.96). There was also a statistically significant reduction in AHI in CPAP group versus placebo (SMD -3.65, 95% CI -5.31 to -1.98). Nocturnal oxygen did not show significant reduction in AHI compared to placebo CPAP (SMD -0.32, 95% CI -0.74 to 0.08).

**Effects on Mean Nocturnal Oxyhemoglobin Saturation (Figure 3)**

A pooled analysis of 4 studies that reported mean oxyhemoglobin saturation showed that both therapeutic CPAP and nocturnal administration of oxygen lead to significant improvement in oxyhemoglobin saturation compared to placebo CPAP. Comparison of CPAP to nocturnal oxygen did not demonstrate

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### Table 2—Study characteristics and effects of CPAP vs. oxygen therapy in OSA patients

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Design / Total Population</th>
<th>Intervention</th>
<th>Duration</th>
<th>Baseline Data</th>
<th>Variables</th>
<th>CPAP</th>
<th>Oxygen</th>
<th>P-CPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phillips 1990</td>
<td>Randomized crossover / 8</td>
<td>Nasal ( \text{O}_2 ) Nasal Air Nasal CPAP</td>
<td>3 month</td>
<td>20.5 ± 4.8</td>
<td>AHI</td>
<td>3.0 ± 0.9*</td>
<td>16.8 ± 3.2</td>
<td>22.1 ± 5.7</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88.7 ± 2.8</td>
<td>( \text{SpO}_2 )</td>
<td>Mean low ( \text{SpO}_2 )</td>
<td>93.7 ± 0.9</td>
<td>95.9 ± 0.3*</td>
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<td></td>
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<td>Arousal events (n)</td>
<td>70.8 ± 16.6</td>
<td>110.6 ± 1.7</td>
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<td></td>
<td>SSS</td>
<td>2.5 ± 0.3</td>
<td>2.5 ± 0.2</td>
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<td>SBP (mm Hg)</td>
<td>140.8 ± 4.5</td>
<td>139.6 ± 5.2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>DBP (mm Hg)</td>
<td>94.6 ± 2.9</td>
<td>96.4 ± 5.4</td>
</tr>
<tr>
<td>Loredo 2006</td>
<td>RCT / 63</td>
<td>CPAP P-CPAP Oxygen</td>
<td>2 weeks</td>
<td>65.9 ± 28.6</td>
<td>92.7 ± 4.5</td>
<td>92.9 ± 4.4</td>
<td>92.6 ± 5.0</td>
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<td></td>
<td>57.5 ± 32.1</td>
<td>94.0 ± 2.9</td>
<td>93.6 ± 4.8</td>
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<td></td>
<td>64.9 ± 33.7</td>
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<tr>
<td>Norman 2006</td>
<td>RCT / 46</td>
<td>CPAP P-CPAP Oxygen</td>
<td>2 weeks</td>
<td>66.1 ± 29.1</td>
<td>92.7 ± 4.5</td>
<td>92.9 ± 4.4</td>
<td>92.6 ± 5.0</td>
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<td>53.9 ± 29.8</td>
<td>94.0 ± 2.9</td>
<td>93.6 ± 4.8</td>
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<td></td>
<td>60.7 ± 29.6</td>
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<tr>
<td>Mills 2006</td>
<td>RCT / 50</td>
<td>CPAP P-CPAP Oxygen</td>
<td>2 weeks</td>
<td>65.0 ± 8.3</td>
<td>93.0 ± 4.8</td>
<td>94.0 ± 3.1</td>
<td>92.8 ± 5.5</td>
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<td>61.2 ± 8.2</td>
<td>94.0 ± 3.1</td>
<td>92.8 ± 5.5</td>
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<td>61.8 ± 9.4</td>
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<tr>
<td>Bardwell 2007</td>
<td>RCT / 38</td>
<td>CPAP P-CPAP Oxygen</td>
<td>2 weeks</td>
<td>59.4 ± 31.1</td>
<td>93.0 ± 4.8</td>
<td>94.0 ± 3.1</td>
<td>92.8 ± 5.5</td>
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<td></td>
<td></td>
<td>59.3 ± 28.1</td>
<td>94.0 ± 3.1</td>
<td>92.8 ± 5.5</td>
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<td>67.2 ± 35.8</td>
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<tr>
<td>Lim 2007</td>
<td>RCT / 46</td>
<td>CPAP P-CPAP Oxygen</td>
<td>2 weeks</td>
<td>63.5 ± 7.8</td>
<td>93.1 ± 1.1</td>
<td>92.3 ± 1.3</td>
<td>93.2 ± 1.4</td>
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<td>65.8 ± 8.2</td>
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<td>58.6 ± 8.3</td>
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<td>93.2 ± 1.4</td>
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</table>

RCT, randomized controlled trial; CPAP, continuous positive airway pressure; P-CPAP, placebo CPAP; \( \text{O}_2 \), oxygen, n, number of patients; AHI, apnea-hypopnea index; SSS, Stanford Sleepiness Score; ESS, Epworth Sleepiness Score; ODI, oxygen desaturation index; TAI, total arousal Index; RDI, respiratory disturbance index; SBP, systolic blood pressure; DBP, diastolic blood pressure. *Statistically significant change from placebo (p < 0.05). †Statistically significant change from oxygen (p < 0.05). ‡Statistically significant change from baseline (p < 0.05). AHI, apnea-hypopnea index; RDI, respiratory disturbance index; SSS, Stanford Sleepiness Score; ESS, Epworth Sleepiness Score; ODI, oxygen desaturation index; TAI, total arousal Index; RDI, respiratory disturbance index; SBP, systolic blood pressure; DBP, diastolic blood pressure. *Statistically significant change from placebo (p < 0.05). †Statistically significant change from oxygen (p < 0.05). ‡Statistically significant change from baseline (p < 0.05). AHI, apnea-hypopnea index; RDI, respiratory disturbance index; SSS, Stanford Sleepiness Score; ESS, Epworth Sleepiness Score; ODI, oxygen desaturation index; TAI, total arousal Index; RDI, respiratory disturbance index; SBP, systolic blood pressure; DBP, diastolic blood pressure. *Statistically significant change from placebo (p < 0.05). †Statistically significant change from oxygen (p < 0.05). ‡Statistically significant change from baseline (p < 0.05).
### Table 3—Study characteristics and effects of oxygen therapy in OSA patients

<table>
<thead>
<tr>
<th>Study ID</th>
<th>Design</th>
<th>Study Population (n) Type / Total</th>
<th>Intervention</th>
<th>Baseline Data</th>
<th>Variables</th>
<th>Oxygen</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kearley 1980</td>
<td>Single Cohort OSA with COPD / 11</td>
<td>1st half of night: Air(Control) ↓ 2nd half of night: O₂</td>
<td>69 ± 10 94 ± 0.06</td>
<td>O₂ desaturation episodes/h 0.7* 4.5</td>
<td>SDB events/h 6.3 13.7</td>
<td>SDB event duration (sec) 30.9 23.6</td>
<td></td>
</tr>
<tr>
<td>Smith 1984</td>
<td>Single Cohort randomized study OSA with EDS / 12</td>
<td>1 night: Air(Control) ↓ 1 night: O₂</td>
<td>77 ± 16 86 ± 2</td>
<td>SaO₂ (%) 96 ± 0.6† 94 ± 0.06</td>
<td>SDB events/h 56 ± 11 69 ± 10</td>
<td>SDB event duration (sec) Same in both groups</td>
<td></td>
</tr>
<tr>
<td>Gold 1986</td>
<td>Single Cohort nonrandomized trial OSA / 8</td>
<td>1 month: Air(Control) ↓ 1 month: O₂</td>
<td>88.2 ± 27 87.7 ± 0.6</td>
<td>SaO₂ (%) 96 ± 2* 87.7 ± 6.6</td>
<td>SDB events/h 67.4 ± 21.8 88.2 ± 26.9</td>
<td>SDB event duration (sec) 31.4 ± 9.8† 25.7 ± 7.9</td>
<td></td>
</tr>
<tr>
<td>Alford 1986</td>
<td>Single Cohort Crossover Study OSA (SDB &gt; 50/h) with COPD / 20</td>
<td>1 night: Air(Control) ↓ 1 night: O₂</td>
<td>52.7 ± 10.4 89.4 ± 0.93</td>
<td>SaO₂ (%) 92.0 ± 1.1† 89.4 ± 0.93</td>
<td>SDB events/h 38.9 ± 9.3* 52.7 ± 10.4</td>
<td>DBP (mm Hg) 75 ± 4† 82 ± 4</td>
<td></td>
</tr>
<tr>
<td>Block 1987</td>
<td>Single Cohort nonrandomized nonblinded study OSA (AHI &gt; 5) / 20</td>
<td>1st half of night: Air(Control) ↓ 2nd half of night: O₂</td>
<td>52.7 ± 10.4 89.4 ± 0.93</td>
<td>SaO₂ (%) 92.0 ± 1.1† 89.4 ± 0.93</td>
<td>SDB events/h 38.9 ± 9.3* 52.7 ± 10.4</td>
<td>DBP (mm Hg) 75 ± 4† 82 ± 4</td>
<td></td>
</tr>
<tr>
<td>Pokorski 2000</td>
<td>Single Cohort Single blind trial Pre-surgical OSA patients / 5</td>
<td>1 night: Air(Control) ↓ 1 night: O₂</td>
<td>28.6 ± 15.6 82.4 ± 4.73</td>
<td>SaO₂ (%) 93.3 ± 3.4* 82.4 ± 4.73</td>
<td>SDB events/h (RDI) 28.6 ± 15.6 33.1 ± 8.7</td>
<td>ESS 12* 14</td>
<td></td>
</tr>
<tr>
<td>Friedman 2001</td>
<td>Single Cohort nonrandomized nonblinded study OSA / 21</td>
<td>1st half of night: O₂ ↓ 2nd half of night: Air(Control)</td>
<td>31.1 ± 8.8 94.2 ± 1.2</td>
<td>SaO₂ (%) 97.7 ± 0.9* 94.2 ± 1.2</td>
<td>SDB events/h (AHI) 12.7 ± 8.5* 31.1 ± 8.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kumagai 2008</td>
<td>Single Cohort nonrandomized study OSA patients on PD / 11</td>
<td>1 month: O₂</td>
<td>—</td>
<td>94.7 ± 1.7</td>
<td>O₂ desaturation &lt; 90% 36* 91</td>
<td>SDB events/h 14 11</td>
<td>SDB event duration (sec) 29† 22</td>
</tr>
</tbody>
</table>

ID, identification; Dx, diagnosis; OSA, obstructive sleep apnea; n, number; M, male; F, female; O₂, oxygen; PSG, polysomnography; AHI, apnea-hypopnea index; RDI, respiratory disturbance index; PD, peritoneal dialysis. All data in mean or mean ± SD. *p < 0.01, †p < 0.001, ‡p < 0.05.

### Figure 2—Effect of CPAP versus oxygen on apnea hypopnea index (AHI)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>SMD (95% CI)</th>
<th>% Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phillips 1990</td>
<td>-5.87 (-8.26, -3.49)</td>
<td>14.46</td>
<td></td>
</tr>
<tr>
<td>Loredo 2006</td>
<td>-2.53 (-3.33, -1.73)</td>
<td>22.69</td>
<td></td>
</tr>
<tr>
<td>Norman 2006</td>
<td>-1.89 (-2.76, -1.03)</td>
<td>22.42</td>
<td></td>
</tr>
<tr>
<td>Mills 2006</td>
<td>-6.27 (-7.95, -4.60)</td>
<td>18.22</td>
<td></td>
</tr>
<tr>
<td>Bardwell 2007</td>
<td>-1.73 (-2.64, -0.81)</td>
<td>22.21</td>
<td></td>
</tr>
<tr>
<td>Overall (I-squared = 87.4%, p = 0.000)</td>
<td>-3.37 (-4.79, -1.96)</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Weights are from random effects analysis.

Standardized mean difference

Favors CPAP Favors oxygen

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275  
*Journal of Clinical Sleep Medicine, Vol. 9, No. 3, 2013*
a significant difference in the degree of improvement in oxy-
genation (SMD 0.07, 95% CI -0.27 to 0.41).

Meta-Analysis of Observational Studies

Effects on SDB events (Figure 4)
A pooled analysis of 6 observational studies showed signif-
ificant reduction in SDB events with oxygen compared to air
(SMD -0.95, 95% CI -1.69 to -0.21).

Effects on Mean Nocturnal Oxyhemoglobin Saturation (Figure 5)
A pooled analysis of 6 observational studies showed signifi-
cant improvement in mean oxyhemoglobin saturation with oxy-
gen compared to air (SMD 2.45, 95% CI 1.49 to 3.4).

Effects on Sleep Disordered Breathing (SDB) Event Duration
We identified 5 observational studies reporting the SDB
event duration as an outcome.30-33 We could not pool the re-
results of these studies for statistical analysis due to the lack
of sufficient data. However, 3 of these studies reported that
administration of oxygen lead to the prolongation of SDB
event duration.31-33

DISCUSSION

In this systematic review, we identified and reviewed 14
studies evaluating the effects of oxygen supplementation for
the treatment of intermittent nocturnal hypoxemia in patients
with OSA. We performed a meta-analysis of the six random-
ized controlled trials that evaluated the effect of CPAP, placebo
CPAP, versus oxygen on AHI and SpO2. In this analysis, pa-

tients with obstructive sleep apnea who used CPAP had signifi-
cant reduction in AHI compared to those who used nocturnal
oxygen. However, both nocturnal oxygen and CPAP improved
oxyhemoglobin saturation equally.

Obstructive sleep apnea is a prevalent disorder with its seri-
ous health related consequences.37 Many patients with sleep
apnea have intermittent episodes of hypoxemia at night sec-
ondary to the periods of the upper airway obstruction. These
episodes have been shown to be associated with harmful se-
quelae including insulin resistance, cognitive deficit, and the development of other cardiovascular morbidity.36-40 Both nasal CPAP and nocturnal administration of oxygen improve oxyhemoglobin saturation, but nocturnal oxygen has little effect on the blood pressure surge following apneas in patients with sleep apnea.41-43 On the other hand, CPAP has been shown to lower the blood pressure variability in patients with sleep apnea.25,26 This suggests that there might be some other factors such as hypercapnia, arousals, respiratory efforts, intrathoracic pressure changes, or fragmented sleep contributing to the increase in the blood pressure seen in sleep apnea.44-47 In a study in human adults, the arousals from NREM sleep was shown to increase the sympathetic discharge with increase in the systolic blood pressure.48

Patients with OSA frequently have cognitive dysfunction and excessive daytime sleepiness (EDS), possible secondary to the combination of hypoxemia and fragmented sleep. These symptoms worsen with increasing severity of hypoxemia and increasing frequency of arousals. Nasal CPAP improves both the arousals and hypoxemia and thereby has been shown to improve the sleepiness in contrast to the nocturnal administration of oxygen.23,25,26 This suggests that there might be some other factors such as hypercapnia, arousals, respiratory efforts, intrathoracic pressure changes, or fragmented sleep contributing to the increase in the blood pressure seen in sleep apnea.44-47 In a study in human adults, the arousals from NREM sleep was shown to increase the sympathetic discharge with increase in the systolic blood pressure.48

In conclusion, the evidence from the controlled trials does support the preferential use of CPAP over oxygen in patients with OSA since CPAP significantly improves the oxyhemoglobin saturation and reduces AHI and systemic blood pressure with improvement in daytime sleepiness. On the other hand, oxygen therapy is a double-edged sword, which not
only lengthens the apnea duration but potentially increases the risk of hypercarbia with minimal to no effect on blood pressure and daytime sleepiness. Hence, at present it is difficult to recommend oxygen therapy for patients who are non-adherent with CPAP until the results of a multicenter clinical trial, Heart Biomarker Evaluation in Apnea Treatment, are available.

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