Treatment with Nasal CPAP Decreases Automobile Accidents in Patients with Sleep Apnea

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We studied 50 consecutive patients to test the hypothesis that successful treatment of obstructive sleep apnea with nasal continuous positive airway pressure (nasal CPAP) will decrease automobile accidents in patients with sleep apnea. Thirty-six (72%) of the patients reported using nasal CPAP regularly during 2 yr. Fourteen patients reported they had not used CPAP during 2 yr. The patients with sleep apnea in this study had a higher automobile crash rate than all drivers in the state of Colorado (0.07 versus 0.01 crash per driver per year, p < 0.02). Patients who were treated with nasal CPAP had a lower crash rate while being treated than before treatment (0.07 versus 0 crash per driver per year, p < 0.03). Untreated patients with sleep apnea continued to have a high crash rate (0.07 crash per driver before and after diagnosis). Drivers with sleep apnea were reluctant to report their automobile crashes, for the drivers in this study reported only one-third of the crashes in which they were involved. This is the first study to confirm with traffic records that patients with sleep apnea have fewer automobile crashes while being treated with nasal CPAP. Findley L, Smith C, Hooper J, Dineen M, Suratt PM. Treatment with nasal CPAP decreases automobile accidents in patients with sleep apnea.


Subjects
A II patients studied at the Sleep Disorders Center of Northern Colorado from August 1991 to August 1994 were asked to participate in this study if they had obstructive sleep apnea, underwent a successful nasal CPAP titration study, completed a questionnaire about driving and automobile crashes, and had a Colorado driver’s license. A total of 234 patients were studied in our laboratory from August 1991 to August 1994; 167 patients did not have obstructive sleep apnea, 67 patients had obstructive sleep apnea. We were able to contact 51 of these patients and 50 agreed to answer questions about their use of CPAP and driving habits in a telephone interview. There were 43 males and 7 females, 56 ± 2 yr of age (mean ± SEM). Patients complained of loud snoring, daytime sleepiness, or nocturnal sleep disturbances. Patients with a history of narcolepsy, seizure disorder, chronic lung disease, chronic sedative intake, or alcohol abuse were excluded. Each patient gave informed consent and the protocol was approved by the Human Subjects Committee of McKee Medical Center.

Driving Records
The names of the patients with sleep apnea were sent to the Department of Motor Vehicles (DMV) of the State of Colorado and driving records were obtained for the 2 yr before and 2 yr after diagnosis. A driver’s accident record is public record in Colorado. To protect the patients’ privacy, the names were submitted to the DMV without identifying these patients as having sleep apnea. Automobile accidents were defined as those that resulted in property damage greater than $500 or personal injury for which the driver was convicted of a traffic violation. These accidents were considered to be those in which the driver was at fault.

Interview
A II patients were asked several questions concerning their usage and the effect of CPAP on their driving ability during a telephone interview by one member of the research team. Each patient esti-
mated the number of nights per week and the number of hours per night they used their CPAP. Each patient was asked to estimate the number of miles they drove an automobile per year before and after diagnosis of sleep apnea, the number of auto crashes since diagnosis, and what effect the use of CPAP had upon their driving ability.

Statistical Analysis
Comparison of variables between the patients who did and did not use CPAP was made with the nonparametric Mann-Whitney test. Comparison of the number of patients with a crash between groups was made with the Fisher exact test. Confidence intervals were ± 95%.

RESULTS
Comparison of Patients who Did and Did not Use CPAP
The 50 patients consisted of 43 men and seven women. The age was 56 ± 2 yr (mean ± SEM) with a weight of 233 ± 80 pounds. These patients had 37 ± 3.8 apneas + hypopneas per hour of sleep. Thirty-six (72%) of the patients reported using nasal CPAP regularly during the past 2 yr. They reported using CPAP daily for 7.2 ± 0.3 h per night each night. Fourteen patients reported they had either elected not to use the CPAP at home or returned the CPAP within 1 mo of receiving it. None of these patients had surgery or other treatment for their sleep apnea. Table 1 gives descriptive data on the two groups. There were no significant differences in the patients who did use CPAP and who did not use CPAP on the following characteristics: age, gender, weight, and number of apneas + hypopneas per hour of sleep on their initial sleep study. The number of apneas + hypopneas were significantly decreased with CPAP treatment in the 36 patients who did use the CPAP (37 ± 5 versus 2.6 ± 0.8 apneas + hypopneas per hour of sleep, p < 0.01).

Automobile Crashes Before and After CPAP
The 50 patients had a high crash rate during the 2 yr before the diagnosis of sleep apnea. Seven of these 50 patients with sleep apnea had an automobile crash during the 2 yr before diagnosis of their sleep apnea (0.07 crash per driver per year; confidence interval [CI] = 0.03 to 0.14). The automobile accident rate for these patients with sleep apnea was significantly higher than the accident rate for all drivers in Colorado (0.01 crash per driver per year, p < 0.02) (Table 2). Because older drivers tend to have a lower rate of accidents, and because males tend to have a higher rate of accidents, we adjusted the crash rate for all drivers in Colorado for the age (mean age of 55 yr) and gender (86% male) of our 50 patients. This adjustment increased the Colorado rate by 13%. This adjusted Colorado rate was still significantly less than the rate for the 50 patients with sleep apnea (p < 0.02).

The 36 drivers who successfully used CPAP had a lower accident rate during the 2 yr they used CPAP. Five of the 36 drivers who successfully used CPAP had an accident 2 yr before their diagnosis of sleep apnea (0.07 crash per driver per year, CI = 0.03 to 0.16), whereas none of these 36 patients had an accident during the 2 yr they were treated with CPAP (0.0 crash per year, CI = 0.0 to 0.50; p < 0.03) (Table 2). This decrease in accident rate was not caused by decreased driving while wearing CPAP, since the estimated miles driven per year were not significantly different (13.6 ± 2.2 before versus 12.9 ± 2.1 thousand miles per year). Seventy-five percent of the patients who were treated with CPAP said they were a better driver after they began using CPAP.

The 14 patients with sleep apnea who were not treated for sleep apnea continued to have a high automobile crash rate. Two of the 14 patients with sleep apnea who did not use CPAP had an automobile crash during the 2 yr before their diagnosis (0.07 crash per driver per year, CI = 0.01 to 0.25). During the 2 yr after diagnosis and without treatment, two of the 14 had an accident (0.07 crash per driver per year, CI = 0.01 to 0.25) (Table 2). One of the drivers who had a crash after diagnosis had a crash 2 yr before the diagnosis of sleep apnea, the other driver had not had a crash the 2 yr before diagnosis.

The patients with sleep apnea were reluctant to report their automobile crashes on a questionnaire or during a telephone interview. There were 9 automobile crashes in these patients with sleep apnea (7 crashes before diagnosis and 2 crashes after diagnosis). Only 3 of these 9 crashes (33%) were reported on the questionnaire or during the telephone interview. Four crashes were denied and two patients who had crashes refused to answer the question about crashes.

DISCUSSION
The patients with sleep apnea in this study had a higher automobile crash rate before treatment than all drivers in Colorado. Patients who were treated with nasal CPAP had a lower crash rate while being treated than before treatment. Untreated patients with sleep apnea continued to have a high crash rate. Drivers with sleep apnea reported only one-third of the number of automobile crashes in which they were involved.

Previous studies have shown that patients with sleep apnea perform poorer than control subjects on several types of driving simulators (15–17). Their automobile crash rate is 2 to 3 times greater than all drivers (3, 4, 6–10). These crashes may cause serious injury or death (18). Successful treatment of sleep apnea improves performance in driving simulator tests (15, 19–21).

Five studies have shown that treatment of sleep apnea with nasal CPAP may decrease self-reported automobile crashes. Suratt and Findley (11) interviewed 22 patients with sleep apnea who had successfully used nasal CPAP for 2 yr. They found that 41% of 22 patients with sleep apnea reported at least one accident during the 2 yr before treatment with CPAP.

### Table 1
**Comparison of Patients using CPAP to Those not using CPAP**

<table>
<thead>
<tr>
<th>Patients Using CPAP</th>
<th>Patients Not Using CPAP</th>
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<tbody>
<tr>
<td>n</td>
<td>36</td>
</tr>
<tr>
<td>Gender, M/F</td>
<td>30/6</td>
</tr>
<tr>
<td>Age, yr*</td>
<td>54 ± 2</td>
</tr>
<tr>
<td>Weight, lb*</td>
<td>239 ± 10</td>
</tr>
<tr>
<td>A + H†</td>
<td>37.9 ± 5.0</td>
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</tbody>
</table>

* Values are mean ± SEM.
† Apneas + hypopneas per hour of sleep.

### Table 2
**Auto Accident Rates in Patients using CPAP and Untreated Patients**

<table>
<thead>
<tr>
<th>Patients Using CPAP</th>
<th>Untreated Patients</th>
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</thead>
<tbody>
<tr>
<td>n</td>
<td>36</td>
</tr>
<tr>
<td>No. of accidents before diagnosis</td>
<td>5</td>
</tr>
<tr>
<td>No. of accidents after diagnosis</td>
<td>0†</td>
</tr>
<tr>
<td>Accident rate* before diagnosis</td>
<td>0.07</td>
</tr>
<tr>
<td>Accident rate after diagnosis</td>
<td>0†</td>
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</tbody>
</table>

* Accidents/driver/year.
† Significant reduction with CPAP (p < 0.03).
whereas 5% of these patients had an accident during the 2 yr of treatment ($p < 0.05$). Near accidents were reported in 59% of these patients during 2 yr before treatment versus 0% with near accidents during 2 yr of treatment with CPAP ($p < 0.05$). Minemura and colleagues (12) found that 42% of 14 patients with sleep apnea reported at least one accident during the 3 yr before treatment with CPAP whereas 0% of these patients had an accident during a year of treatment. Near accidents were reported in 64% of these patients before treatment versus 0% with near accidents during treatment with CPAP ($p < 0.05$). Engleman and coworkers (13) found that near crashes and automobile crashes were significantly reduced after nasal CPAP treatment in 147 patients (39% reporting before treatment and 5% after treatment $p < 0.01$). Cassel and coworkers (14) found that 59 patients with obstructive sleep apnea reported a markedly decreased automobile crash rate after 1 yr of treatment with CPAP (0.8 crash per 100,000 km untreated versus 0.15 crash per 100,000 km with CPAP $p < 0.01$). These 59 patients had less daytime sleepiness measured by multiple sleep latency studies and improved daytime performance on an 80-min vigilance test ($p < 0.05$). Krieger and his colleagues studied questionnaires from 547 patients treated with nasal CPAP (10). They found that 46% of these patients reported an automobile crash during the year before treatment with CPAP while 14% reported a crash the first year of treatment with CPAP.

One previous study has examined reporting of driving impairment in patients with sleep apnea. Engleman and associates found that patients with sleep apnea under report their degree of driving impairment (22). Ninety-nine patients with sleep apnea who were treated with nasal CPAP reported any driving impairment due to sleepiness before treatment. There were significantly more patients who admitted to impairment of driving owing to sleepiness after they were treated with CPAP (23% before treatment versus 37% after treatment, $p < 0.05$). These investigators suggest that untreated patients with sleep apnea minimize their symptoms.

This study can be faulted for not measuring CPAP usage with a convert monitor. Convert monitors were not available when the study was begun. Finally, if there were subjects who reported regular use of CPAP, but did not regularly use CPAP, these subjects would be more likely to have automobile crashes and therefore would bias against our hypothesis of fewer crashes while using CPAP. In our study, patients were not randomized into untreated and CPAP-treated groups. Therefore, an alternative explanation for the differences between the treated and untreated groups could be that the same psychological characteristics which lead the untreated to refuse CPAP would lead them to more risky driving behavior and more accidents. This would not explain the higher accident rate in the entire group of patients with sleep apnea than the drivers in the state of Colorado. The evaluation of mileage is left to the patient self-report and this could be another source of error.

This is the first study to confirm with DMV records that patients with sleep apnea have fewer automobile crashes while being treated with nasal CPAP. This finding indicates that patients with sleep apnea have fewer crashes while using nasal CPAP; the driving privileges of these patients may not have to be revoked to protect themselves and others from injury. This study also shows that some patients with sleep apnea are reluctant to report automobile crashes, and that self-reporting of automobile crashes by patients to their physicians may not be reliable.

References