



Obstructive sleep apnoea and risk of motor vehicle accident: a perspective

Nathaniel Marshall, Philippa Gander and Alister Neill

Obstructive sleep apnoea syndrome (OSAS) is a common sleep breathing disorder characterized by repetitive episodes of upper airway obstruction (apnoea) or narrowing (hypopnea), loud snoring and daytime sleepiness.¹ Obstructive events are terminated by brief arousals leading to fragmented sleep. Based on polysomnographic diagnosis (the gold standard), the prevalence of adult OSAS, defined as five or more apnoeic/hypopnoeic episodes per hour and daytime sleepiness, has been estimated at 2% for women and 4% for men.² Anecdotal evidence from sleep clinics and surveys of risk factors suggests that the prevalence may be higher among Maori and Polynesian New Zealanders.^{3,4} It seems likely that the majority of OSAS sufferers in New Zealand remain undiagnosed, given the limited number of specialist services for sleep disorders.

Optimum therapy for OSAS depends on age, severity of the condition, and the balance of aetiological risk factors.⁵ Nasal continuous positive airway pressure (CPAP) is regarded as the first line of therapy for moderate to severe OSAS.⁶ There is good evidence for its effectiveness in reducing nocturnal and diurnal symptoms of patients with moderate to severe OSAS, but the results for milder disease are equivocal.^{7,8} Longer-term CPAP compliance remains a significant clinical issue; objective compliance has been reported between 46% and 75% at around 3.5 months.⁹

The neurocognitive effects of OSAS, including daytime somnolence, decreased vigilance, and impaired psycho-motor reaction time,¹ are thought to account for the increased risk of motor vehicle accidents (MVAs) among untreated sufferers. This has drawn the attention of regulatory authorities in a number of countries.¹⁰⁻¹² The debate centres on whether or not OSAS sufferers should be allowed to hold certain categories of driving licence, and on the conditions under which treated OSAS sufferers should be allowed to continue to drive. This context prompted us to undertake a review of the recent scientific evidence for increased MVA risk amongst OSAS sufferers, and of the evidence that this risk could be reduced by treatment with nasal CPAP. A previous review has addressed sleepiness as a factor in occupational driving accidents in Australasia.¹³ Since this review a number of significant studies have been published that support the effectiveness of nasal CPAP in reducing MVA risk.

Evidence for increased accident risk in OSAS drivers

Reliable studies in this area are those that include polysomnographic diagnosis of OSAS and a robust measure of MVA involvement compared with an appropriate control group. Recent examples are considered below. However, a significant weakness in these studies is that driving exposure is not controlled for.

In a population-based sample of 913 Wisconsin-State employees, Young et al found that men with an apnoea/hypopnea index (AHI) >15 (ie, averaging more than 15 such

events per hour of sleep) were 3.4 times more likely to be involved in *at least one* MVA over a five-year period.¹⁴ When combining men and woman in this sample, those with an AHI >15 were 7.3 times more likely to have been involved in *multiple* MVAs during this period. Accident data were verified by the mandatory state accident database, and because this study was population based these data are free of referral bias. Findley et al evaluated a sample of 50 consecutive OSAS patients (mean AHI = 37), and found 7 times the average crash rate of Colorado drivers.¹⁵ This study also revealed that this group of OSAS patients under-reported accident involvement, admitting only one third of the accidents documented in official state records. In an Ontario study, 210 OSAS patients (mean AHI = 54) had three times as many MVAs prior to diagnosis as a control group selected at random from a provincial database and matched for age, sex, and type of driver's licence.¹⁶ A caveat regarding this study is that the patients' estimated annual mileage was about double the provincial average.

In a case control study, Teran-Santos et al present findings from 102 drivers who had crashed on motorways and required emergency room treatment, compared with 152 randomly selected, primary care patients who had not crashed in the past two months.¹⁷ After in-home screening followed by laboratory polysomnography, it was found that those with OSAS (AHI >9.9) had an independent odds ratio of 6.2 (2.4–16.2) for having an accident. Consumption of alcohol further increased the risk of accident in those with OSAS. This study had the drawback that the cases drove around 7000km/year more than the controls, which may explain some of the increased risk observed.

In New Zealand, Yee et al have investigated sleep breathing disorders in people reporting for treatment in the Emergency Department of Wellington Hospital following a motor vehicle accident.¹⁸ Of a potential 120 drivers, 40 completed overnight polysomnography and sleep questionnaires. Fourteen of the 40 (35%) were found to have OSAS and 9 (22.5%) had another sleep disorder or chronic sleep restriction. Of the same sample, 15% had OSAS with an AHI of >15 – a severity that has been shown to increase the risk of MVAs. Although this is an uncontrolled study and response rate is low, the results were comparable to the findings of Teran-Santos et al.¹⁷ This suggests that New Zealand MVA rates are impacted by sleep disorders, particularly OSAS.

Additional studies that have specifically addressed the issue of OSAS severity and driving risk include a published letter that compared the accident rates of all drivers in the State of Virginia with those of 16 patients with mild OSAS, 17 with moderate OSAS, and 13 with severe OSAS.¹⁹ Only the patients with severe OSAS (defined by nocturnal hypoxaemia) differed significantly from the State average. A more comprehensive study compared accident rates and citations for five years prior to diagnosis among 229 patients with mild OSAS (AHI 10–25), 107 patients with moderate OSAS (AHI 26–40), and 246 patients with severe OSAS (AHI >40). The control group, selected at random from the Ontario driver database, was matched for age, gender, and type of driver's licence.²⁰ Only those patients with severe OSAS averaged significantly more accidents a year than controls (0.11 vs 0.07). OSAS patients also had twice as many traffic citations as controls (1.74 vs 0.86), for similar types of offences.

Evidence for poorer driving performance

Another line of evidence supporting an increased accident risk is the performance of OSAS sufferers in driving simulators. In a one-hour simulation (between 1000 and 1300 hours), 15 patients (mean AHI = 47) had worse simulated driving performance, and were more prone to EEG-measured 'micro-sleeps', than controls.²¹ The controls were slightly younger and not gender-matched (younger males are at higher risk in real accidents, but females are more likely to crash in some simulated environments). The performance of the OSAS patients deteriorated across the simulation when compared with the controls. A second study compared 12 OSAS patients (entry criteria: 10 oxygen desaturations/hour of at least 4% and an Epworth Sleepiness Score >10) with 12 controls matched for age, gender, and driving experience.²² The study included three 30-minute simulation runs controlled for time of day and in three simulated conditions of visibility. Lane deviation, off-road events, and a secondary-task reaction time were monitored. OSAS patients were found to perform significantly worse than controls on all measures.

Evidence for reduced risk with CPAP treatment

There are no randomized placebo-controlled trials specifically examining the effect of CPAP treatment on subsequent real-life accident risk in OSAS patients. One randomized parallel trial has compared the effects on simulator driving performance of one month of therapeutic versus placebo nasal CPAP (air pressures insufficient to splint the airway open) in men with moderate to severe OSAS.²³ Inclusion criteria were >10 oxygen desaturations of at least 4% per hour due to pharyngeal collapse, combined with an Epworth Sleepiness Score >10. The study included 26 men receiving therapeutic CPAP and 33 receiving placebo CPAP. Before and after the treatment period, participants performed three 30-minute simulation runs controlled for time of day and in three simulated conditions of visibility. Nocturnal hypoxaemia, objective and subjective measures of sleepiness, steering performance, and secondary-task reaction time improved in the therapeutic CPAP group when compared with the placebo CPAP group. Simulated crash events (off-road events) did not improve compared with placebo.²³

Two recent, non-randomized studies support a reduction in accident risk following CPAP treatment. In the first, the official accident records of 50 consecutive OSAS patients (mean AHI = 37) were compared for two years pre-treatment and during two years of either regular nasal CPAP use (subjectively reported nightly average 7.2 hours, 36 patients) or elective non-use of CPAP (14 patients).¹⁵ The patients on CPAP showed a reduction in accident rates from 0.07 to 0 accidents per driver per year, whereas the patients who did not use CPAP had the same accident rate before and after diagnosis (0.07 accidents/year). However, as a non-randomized trial it remains possible that some factor other than non-compliance with CPAP resulted in a continued risk of motor vehicle accident in the 14 patients. In the second study, official accident data were compared for 210 OSAS patients (mean AHI = 54) for three years prior to diagnosis and three years following commencement of CPAP treatment.¹⁶ Accident data for the same six-year period were obtained for a control group selected at random from a provincial database and matched for age, sex, and type of driver's licence.¹⁶ The accident rate for OSAS patients dropped significantly with CPAP treatment (from 0.18 to 0.06 crashes per driver per year), while it

remained unchanged for controls (0.06 in the first three years, 0.07 in the second three years).

Despite the above evidence, active debate is ongoing as to the level of OSAS severity at which risk increases above normal levels, the magnitude of the increased risk, and who can be successfully treated to reduce risk and by what methods.

Predicting who is at risk

Although they are at increased risk, most of the OSAS patients studied have not had a recent motor vehicle crash.¹⁶ It would be desirable to be able to objectively identify individuals at risk of crashing. Several studies have sought relationships between nocturnal measures of OSAS severity (for example AHI, sleep fragmentation, and hypoxaemia) and objective measures of daytime sleepiness. The latter include the Multiple Sleep Latency Test (MSLT), which measures the average time taken to fall asleep in optimal conditions across the waking day, and the Maintenance of Wakefulness Test (MWT), which measures how long a person can stay awake under similar conditions to the MSLT.²⁴ Unfortunately, measures of nocturnal OSAS severity do not correlate well with objective daytime sleepiness. Where statistically significant relationships have been found, they explain only a fraction of the observed variability,²⁵ and cannot be used for predicting individual crash risk.

Excessive sleepiness has many causes other than OSAS.¹ A recent survey of 10 000 people aged 30–60 years and randomly selected from the electoral rolls (71% response rate) found that 37% reported rarely or never getting enough sleep, and 46% reported rarely or never waking refreshed.⁴ The questionnaire also included the Epworth Sleepiness Scale.²⁶ In this sample, 15% of participants scored as moderately sleepy on the Epworth Sleepiness Scale (11–15) and 4% scored in the range indicating severe daytime sleepiness (16–24). OSAS is primarily a syndrome of middle age or later, yet there is evidence that the age group at the highest risk of falling asleep at the wheel and crashing is 20–25 years.²⁷

In a recent New Zealand-based case-control study, Connor et al have found that differences between a crash and a non-crash group included driving between 0200 and 0500 hours, and acute, but not chronic, measures of sleep deprivation (after controlling for age, education, ethnicity, and self-reported alcohol consumption).²⁸ Regular, loud snoring, witnessed apnoeas, and a moderate Epworth Sleepiness Score (11–15), all of which may be OSAS symptoms, were actually found to reduce the likelihood of accidents. However, the crash group were younger on average (over-representative of those aged 15–24 years), and may therefore have had a lower prevalence of OSAS, than the non-crash group (typically middle-aged). Both groups reported a lower than expected level of OSAS symptoms, and objective measures of sleep-disordered breathing were not gathered. The authors concluded that acute sleep deprivation (rather than chronic sleepiness), coupled with driving in the early hours, presents a significantly risky behaviour, and that the risk of serious injury or death could be reduced by 19% with behaviour modification amongst the crash group.²⁸

Another New Zealand study, in contrast, indicates that chronic sleepiness may independently increase crash risk among middle-aged adults. Our research group found that in a population sample of people aged 30–60 years, self-reported accidents in the past three years were independently related to reporting never or rarely getting

enough sleep and to reporting any chance of falling asleep in a car, either as a passenger for an hour without a break, or while stopped in traffic for a few minutes (questions 4 and 8 in the Epworth Sleepiness Scale).²⁹ These effects remained significant after controlling for increasing time on the road per week, male gender and lower age, which are all recognised risk factors for automobile crashes. Sleepiness in cars, in the situations described in the Epworth Sleepiness Scale, seems to predispose middle-aged people to all types of crash involvement, not just crashes they felt were specifically due to fatigue or to falling asleep.

In summary, young people have a much higher risk of all accidents and of fall-asleep accidents than middle-aged people. However, within the relatively safe middle-aged group, sleep disorders may play a significant role. Nevertheless, it must be remembered that most people with moderate to severe OSAS will not crash their cars over a three-year period. The difficulty lies in identifying those who are at greater risk of having an accident.

The 1994 review and consensus statement by the American Thoracic Society recommends that the OSAS patient who represents a potential driving risk is one who:

- has a demonstrated real-world risk (a history of sleep-related automobile accidents or a near miss or misses or equivalent event);
- refuses and/or is intolerant of treatment; and
- has not taken steps to reduce their risk of automobile accidents (reducing driving, avoiding driving at times of high sleepiness, etc).³⁰

There is a divergence of opinion among professional bodies both within and between countries as to the criteria that define high risk.¹⁰ The Australasian Sleep Association is currently undertaking a review of this area with comments being sought.³¹

Conclusions

There is robust evidence that patients with OSAS as a population are at increased risk of involvement in motor vehicle accidents. However, a definitive ban on driving by all OSAS sufferers is difficult to defend, as is mandatory reporting of all patients to licensing authorities. These measures may be seen as a disincentive for seeking treatment, and there is reasonable evidence that accident risk can be reduced by effective treatment with CPAP. Furthermore, blanket measures are arguably inequitable, given that there are no reliable predictors of which OSAS patients are likely to be involved in sleepiness-related crashes and that non-OSAS sufferers are also involved in sleepiness-related crashes. In addition, access to specialist sleep-disorder services is not homogeneous throughout New Zealand. The proportion of OSAS sufferers who remain undiagnosed is not known, but is likely to be high. Research to address this issue is in progress. Risk assessment for the individual OSAS patient by necessity remains a clinical decision based on a combination of objective and subjective variables.

Drowsy driving is a much broader societal issue and the general public is largely uninformed about the serious inherent risks. In our view, the LTSA should embark upon a comprehensive public-education programme to reduce drowsy driving, comparable to those that have successfully changed behaviour with regard to drunk driving and the use of seat belts. Greater resources should be allocated to the

diagnosis and treatment of sleep disorders along with a national strategy, developed by the Ministry of Health with input from leading professional bodies, to improve access.

Author information: Nathaniel S Marshall, Doctoral Candidate, Department of Medicine; Philippa H Gander, Professor and Director, Sleep/Wake Research Centre, Department of Public Health; Alister M Neill, Senior Lecturer, Department of Medicine, Wellington School of Medicine and Health Sciences, Wellington

Correspondence: Nat Marshall, Sleep/Wake Research Centre, Research School of Public Health, Massey University, P O Box 756, Wellington. Fax: (04) 380 0629; email: n.s.marshall@massey.ac.nz

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