

Morbidity and mortality of sleep-disordered breathing: obstructive sleep apnoea and car crash

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Provenance

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Competing interests

B. Phillips is a consultant for the Federal Motor Carrier Safety Administration (Washington DC, USA), Ventus and Cephalon (Frazor, PA, USA). B. Phillips has received speaking honorarium from ResMed (Abingdon, UK) and Respironics (Murrysville, PA, USA).

Educational aims

- ▶ To review the results of USA Department of Transportation meta-analysis regarding obstructive sleep apnoea (OSA) and car crash risk.
- ▶ To discuss factors beyond OSA that increase the risk of crash.

Summary

Untreated OSA increases the risk of having a car crash two-fold. In addition, the severity of sleep-disordered breathing, degree of oxygen desaturation, self-reported sleepiness and body mass index (BMI) increase the risk of crash in OSA patients. Continuous positive airway pressure (CPAP) reduces the risk of car crash. The data are insufficient for other forms of treatment to date. Sleep loss, medications and driving conditions have also been found to be factors affecting the risk of crash.

Approximately 5,000 people are killed each year from commercial motor vehicle crashes in the USA [1]. At least 1,120 of these accidents have been associated with sleep-related disorders [2]. In the UK, fatal road traffic accidents

cost over £1 million annually, resulting in a huge burden on society [3]. This article summarises the currently available literature on the association between car crash and OSA and other factors related to crash.

[HERMES syllabus link: module B.19](#)

Does OSA increase the risk of car crash?

OSA causes fragmented sleep patterns, leading to impaired vigilance, delayed reaction times and daytime sleepiness, which are likely to play a role in traffic accidents. The evidence so far suggests that drivers with OSA are at an increased risk of motor vehicle crash when compared with comparable drivers who do not have the disorder. In 1999, GEORGE and SMILEY [4] reported results of the first study to include >1,000 subjects using controls and data from an accident record system. They found that the accident rate in patients with OSA with an apnoea/hypopnoea index (AHI) >40 events per h was double that of controls. A study from Japan including 448 subjects found that the accident rate was almost three times higher in those with an AHI >30 compared with those with an AHI <5 [5]. In addition, a Spanish study discovered a two-fold higher accident rate in 60 patients with OSA compared with 60 controls [6]. A meta-analysis that included 40 studies on OSA and the risk of crash confirms the earlier reports stating that noncommercial drivers with OSA are at a statistically significant increased risk of involvement in motor vehicle crash [7].

Currently the majority of the literature is based on noncommercial drivers with very few studies focusing on commercial drivers. However, it has been found that 20–30% of accidents involving commercial drivers are sleep related [2]. Some studies have also suggested that there may be a higher level of sleep-disordered breathing among drivers of heavy vehicles [8, 9].

Figure 1
Completed ESS where the patient thought there was a much greater chance than a high chance of dozing and decided to add another category and to use 4, rather than 3, to indicate a high likelihood of dozing.

The following sleepiness scale can be helpful in determining how much sleeping disorder you have. How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Use the following scale to choose the most appropriate number for each situation.

0 = would never doze	1 = slight chance of dozing
2 = moderate chance of dozing	3 = high chance of dozing

4 = Always

SITUATION	CHANCE OF DOZING
Sitting and reading	<u>4</u>
Watching Television	<u>4</u>
Sitting, inactive in a public place (theater or movie)	<u>4</u>
As a passenger in a car for an hour without a break	<u>4</u>
Lying down to rest in the afternoon	<u>4</u>
Sitting and talking to someone	<u>4</u>
Sitting quietly after a lunch without alcohol	<u>4</u>
In a car, while stopped for a few minutes in traffic	<u>4</u>

driving down Interstate

For each of the beverages listed, write in the average number that you drink each day.

What disease-related factors are associated with increased crash in OSA patients?

Four factors have been shown to be associated with crash among the general population:

- Presence and degree of daytime sleepiness (measured using the Epworth Sleepiness Scale [10] (ESS; but not the Multiple Sleep Latency Test (MSLT) or the Maintenance of Wakefulness Test (MWT) (figure 1).
- Severity of disordered respiration during sleep.
- Blood arterial oxygen saturation levels.
- BMI (independent of OSA).

Currently, the literature does not support the use of the MSLT or the MWT as a predictor of crash [11]. The ESS has although been demonstrated to be a predictor of the risk of car crash in several studies [5, 6]. The severity of disordered breathing measured by the AHI and the respiratory disturbance index has also been found to be higher in patients with an increased risk of crash [11]. The oxygen desaturation index was found to be equally as predictive as the AHI, suggesting that oximetry might be as useful a tool as polysomnography to identify those individuals at increased risk of crash.

Finally, BMI has been seen as an independent risk factor for car crash independent of whether a person has OSA. For example, in a study on 785 patients with suspected OSA, BMI independently increased the rate of motor vehicle crashes [12], regardless of whether the driver had been diagnosed with sleep apnoea. The authors concluded that obese patients may have difficulty in moving easily in the drivers' seat, reducing their ability to see traffic from behind or to the side, and that obesity may be a marker for mild sleep-disordered breathing events that may not be detected by AHI.

Are there tests that can identify individuals with OSA who are at risk for car crash?

To date, there are no models or psychometric instruments in existence that have been shown to accurately predict which OSA patients will crash. The only thing that is clear is that OSA patients have a higher risk of crashing than those who do

not have OSA; however, it is obvious that not everyone who has OSA will crash. Thus, while higher BMI, AHI and ESS suggest an increased likelihood of crash (along with lower oxygen saturation), there are no tests that can precisely predict which subset of OSA patients are at an increased risk.

A number of portable sleep monitoring systems, though unmonitored and therefore not as accurate as the current reference standard (a sleep study in a specialised sleep laboratory), offer an alternative method by which severity of OSA may be assessed in a large number of individuals at a low cost. This is a useful tool because OSA patients with severe disease are involved in a higher number of crashes than mild OSA patients.

Are any treatments available to reduce the risk of crash in OSA patients?

Continuous positive airway pressure (CPAP) is the treatment of choice for patients with OSA and is effective in improving daytime sleepiness [13–15]. Several studies have investigated the possibility that CPAP reduces the risk of traffic collisions in patients with OSA and all noted a reduction in the risk of a car accident after treatment with CPAP [16–19].

A Japanese study examined the rate of traffic accidents before and after treatment with nasal CPAP using the ESS in 75 male patients with OSA [16]. Patients were evaluated after 2 yrs of treatment with a questionnaire enquiring about their use of CPAP, ESS, self-related depression scale and driving history. In total, 46 responders had continued CPAP treatment for 2 yrs and reported no traffic accidents in this period in comparison with 33% of patients having accidents prior to treatment. This study shows a reduced risk after treatment with CPAP, but relies on self-reported accidents and does not have a control group.

A study by GEORGE [17] included 210 patients with OSA who were being treated with CPAP and 210 randomly selected age- and sex-matched controls. Motor vehicle crash data were obtained from the Ontario Ministry of Transportation and compared for the 3 yrs before and after treatment with CPAP for the patients and for the corresponding time frame for controls. It was found that prior to CPAP treatment OSA patients had a higher rate of crash than the control subjects; however, following CPAP treatment the crash rate

of the OSA group fell to a normal level. Therefore, CPAP removed the increased risk of crash caused by OSA.

A more recent study had similar results when comparing the number of motor vehicle accidents in 80 healthy subjects with 80 patients with OSA during the 2 yrs before and after CPAP treatment was initiated [19]. The results of the study showed that the risk of a car accident was significantly reduced when OSA patients commenced CPAP treatment. However, the results of the study did not support a direct role of CPAP because a similar rate of reduction was seen in control subjects. This could be due to the diagnosis of OSA itself reducing risk as it alerts the driver to be more vigilant and responsible at the wheel when feeling sleepy.

To date, no other treatments used in general practice for OSA (for example medication, dental appliances and upper airway surgery) have been shown to reduce the rate of car crash [11]. Although other technologies may reduce crash risk among individuals with moderate-to-severe OSA, the available evidence to support this is not convincing. Therefore, no conclusions can be made at present regarding other available technologies for the treatment of OSA. Currently, it is also not clear what length of time is required following initiation of an effective treatment to reach a degree of improvement that would permit safe driving.

Are there any crash-related factors beyond OSA?

Sleep duration

The most common cause of sleepiness is not sleep apnoea it is actually a lack of sleep; therefore, this may be an important factor for the risk of crash. A study by PACK *et al.* [20] used the ESS to measure subjective sleepiness and the MSLT to measure objective sleepiness in 247 and 159 commercial drivers with high and low risk of apnoea, respectively. The study showed that both subjective and objective sleepiness were common in commercial drivers and demonstrated that sleep duration is a risk factor for subjective sleepiness, objectively measured sleepiness and performance impairments (figure 2). Performance impairments were similar in drivers who slept an average of <5 h per night and drivers with severe sleep apnoea. However, severe sleep apnoea was only present in 4.7% of the study sample compared with 13.5% of the population having <5 h sleep per night.

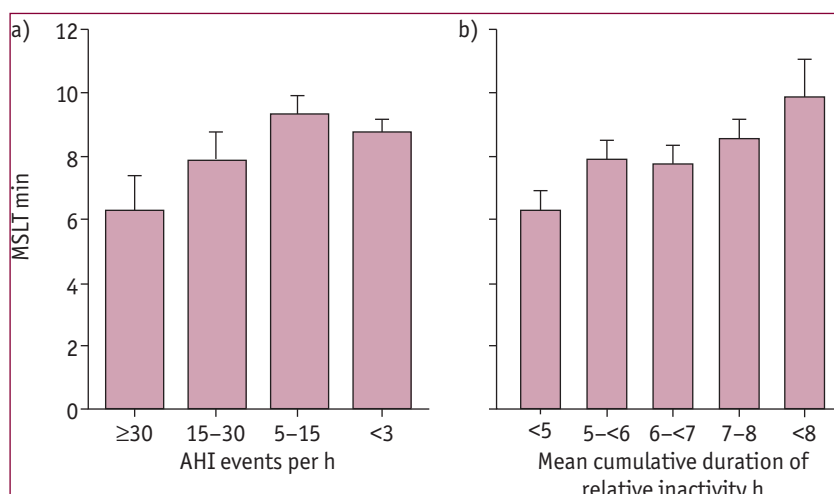


Figure 2

Least-squares estimates of mean MSLT with standard errors controlling for apnoea severity category, sleep duration category, age, sex and BMI. a) AHI category. b) Mean length of cumulative duration of relative inactivity. Reproduced from [19] with permission from the publisher.

Thus, sleep deprivation is likely to be a more common cause of driving impairment than OSA.

Hypnotics

All Norwegians (3.1 million) aged 18–69 yrs were followed-up over a 19-month period in order to examine the rate of traffic accidents associated with benzodiazepine-like hypnotics [21]. Data on prescriptions, road traffic accidents and emigration/death was obtained from three Norwegian population-based registries. Standardised incidence rates (SIRs) showed that flunitrazepam use was associated with a fourfold increase in crash rate, zopiclone and zolpidem doubled the crash rate and nitrazepam use was associated with roughly triple the rate of accidents. The highest SIR for crash was found among the

youngest users for all hypnotics. Therefore, this study strongly suggests that the use of hypnotics increases the rate of car crash.

Other factors

A study carried out on 2,342 commercial drivers in Australia measured the prevalence of excessive sleepiness and sleep-disordered breathing and assessed other accidental risk factors [22]. It found that almost 60% of drivers had sleep-disordered breathing, ~16% had OSA and 24% had excessive sleepiness. The sleepiest 5% of drivers identified by the ESS and Functional Outcomes of Sleep Questionnaire had both an increased risk of accidents and multiple accidents. Interestingly, the study also demonstrated an increased risk of crash for the use of narcotics analgesics, antihistamine use, more time spent driving per week, interstate and country driving and younger age.

Conclusions

Untreated OSA increases the risk of crash by approximately twice. The severity of OSA, degree of oxygen desaturation, self-reported sleepiness (ESS) and BMI (as an independent factor) all affect the risk of car crash. CPAP has been shown to reduce the rate of accidents, but to date no other treatments can be recommended. Importantly, sleep apnoea is not the only risk factor for car crash; insufficient sleep, narcotics, antihistamines and driving conditions have been shown to play a role in the rate of car accidents.

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