Nasal continuous positive airway pressure (nCPAP) treatment for obstructive sleep apnea, road traffic accidents and driving simulator performance: a meta-analysis
Antonopoulos CN, Sergentanis TN, Daskalopoulou SS, Petridou ET

CRD summary
The review concluded that nasal continuous positive airway pressure treatment in people with obstructive sleep apnoea was effective for prevention of real and near-miss road traffic accidents and improved driving simulator performance. The variable and generally poor quality evidence base and potential for bias mean that the authors’ conclusions should be treated with caution.

Authors’ objectives
To assess the effect of nasal continuous positive airway pressure (nCPAP) on road traffic accidents and performance in a driver simulator in patients with obstructive sleep apnoea.

Searching
MEDLINE, EMBASE, Scopus, Bibliosleep and The Cochrane Library databases and Google Scholar were searched from April 1981 to July 2010. There were no language restrictions. Search terms were reported. References lists of retrieved studies and related journals were searched.

Study selection
Randomised and non-randomised studies, editorials, systematic reviews, meta-analyses, short papers, case reports, case series, letters to the editor, personal views and special communications were eligible for inclusion. They were required to assess the effect of nCPAP on obstructive sleep apnoea patients with respect to real and/or near-miss road traffic accidents or performance in the driving simulator. Studies where patients used nCPAP intermittently were excluded.

In the included studies, full polysomnography was used for the diagnosis of obstructive sleep apnoea in all studies, where reported; one study also used respiratory polygraphy. The mostly male participants ranged in mean age from 46 to 57 years and in mean body mass index (BMI) from 30 to 39 kg/m², where reported. A pre-coded questionnaire was used for evaluation of accidents and data were self reported in most studies. Daytime sleepiness was assessed by the Epworth sleepiness scale, Stanford sleepiness scale and the multiple sleep latency test. For assessment of accidents, mean nCPAP treatment ranged from six to seven hours per night. For assessment of driving performance, mean duration of nCPAP treatment ranged from seven to 276 days.

The authors did not state how many reviewers selected studies for the review.

Assessment of study quality
Studies were assessed for quality using criteria based on Scottish Intercollegiate Guidelines Network checklists.

Two reviewers independently assessed studies for quality. Final decisions were made by consensus.

Data extraction
Data on real accidents, near-miss accidents and accident-related events in the driving simulator were extracted and odds ratios (ORs), incident rate ratios (IRR), risk differences (RDs) and mean differences were calculated, each with 95% confidence intervals (CIs). Incident rate ratios were calculated by dividing incidence rates of accidents after nCPAP by the incidence rate before nCPAP. Numbers needed to treat (NNT) were derived from the risk differences. For mean differences, where medians were reported, estimates of the mean were calculated or (in larger sample studies) the median was considered as the mean. Authors of studies were contacted for clarification where data were unclear.

Two reviewers independently extracted data. Disagreements were resolved by consensus.

Methods of synthesis
Studies were pooled in meta-analyses. Summary effect odds ratios, incident rate ratios, risk ratios, NNT and
standardised mean differences (SMDs) and corresponding 95% CIs were calculated with a fixed-effect model (data not heterogeneous) or a random-effects model (heterogeneous data). Heterogeneity was assessed with $\chi^2$ and $I^2$ value. Where heterogeneity was identified, meta-regression was undertaken to assess the association between predictor variables and effect size. Publication bias was assessed by Egger’s regression, Duval and Tweedie’s trim-and-fill test, Kendall's rank correlation coefficient and visual inspection of the forest plots. Rosenthal's fail-safe N test was performed to calculate the number of missing studies needed to result in a statistically non significant overall effect. Sensitivity analyses were undertaken to explore heterogeneity.

**Results of the review**

Fifteen studies (21 investigations) were included in the review. Ten studies (1,221 participants) assessed real accidents. Five studies (769 participants) also assessed near-miss accidents. Six studies (110 participants) assessed performance in the driving simulator. There was one randomised controlled trial (RCT) with a low risk of bias, six observational studies with a low risk of bias, two observational studies with a high risk of bias and six case reports or series.

**Accidents:** nCPAP was associated with a significant reduction in real accidents (OR 0.21, 95% CI 0.12 to 0.35 and IRR 0.45, 95% CI 0.34 to 0.59; 10 studies) and near-miss accidents (OR 0.09, 95% CI 0.04 to 0.21 and IRR 0.23, 95% CI 0.08 to 0.67; five studies). For real accidents, the risk difference was -0.22 (95% CI -0.32 to -0.1, NNT=5, 95% CI 3 to 8; 10 studies) and for near-miss accidents the risk difference was -0.47 (95% CI -0.69 to -0.25, NNT=2, 95% CI 1 to 4; five studies).

**Driving performance:** nCPAP was associated with a significant reduction in accident-related events in the driving simulator (SMD -1.20, 95% CI -1.75 to -0.64; six studies).

Sensitivity analyses did not change the estimates markedly, although for near-miss accidents meta-regression analysis suggested that nCPAP seemed more effective among patients entering the studies with higher baseline accident rates. Some of the tests used to assess publication bias were significant, but the estimates of fail-safe N indicated that a large number of additional studies would be required to overturn the findings.

**Authors’ conclusions**

The review demonstrated a sizeable protective effect of nCPAP on road traffic accidents, both in real life and virtual environment.

**CRD commentary**

The review addressed a clear research question. Inclusion criteria appeared appropriate, although a wide range of study designs were eligible. Several relevant sources were searched for studies. There were no language restrictions. No efforts were made to identify unpublished studies, so some studies may have been missed. However, calculation of fail-safe N suggested that a large number of studies would be required to overturn the findings of the review. Appropriate methods were used to extract data and assess studies for quality, but the authors did not state how many reviewers selected studies for the review so reviewer error and bias could not be excluded.

Appropriate checklists were used to assess studies for quality and the levels of evidence that were reported suggested an overall risk of bias for each study. Only one RCT was identified and seven of the 15 studies were considered at low risk of bias. Several studies did not use comparable control groups so the authors used before versus after comparisons (these are more subject to potential bias). The wide variety of non-compliance rates in the studies meant that selection bias could not be excluded. The retrospective nature of some studies meant that recall and telescopic bias could not be ruled out. It was possible that effects were underestimated because of inaccurate reporting of accidents by participants. It was not possible to determine how efficacy of nCPAP varied with time. The authors pooled the results of the RCT with non-randomised and case series in meta-analyses; since non-randomised studies and case series are more likely to be influenced by bias, synthesis of the results in this way may not have been appropriate. Assessment of heterogeneity was appropriate and comprehensive. There were too few studies to enable accurate interpretation of formal tests used to assess publication bias.

The variable and generally poor quality evidence base and potential for bias mean that the authors’ conclusions should be treated with caution.
Implications of the review for practice and research

**Practice:** The authors stated that nCPAP use in obstructive sleep apnoea patients should be encouraged and represented an efficient use of health care resources. They stated that the driving simulator should be considered a useful tool for assessing the improvement in driving in obstructive sleep apnoea patients.

**Research:** The authors stated that future research should simultaneously assess the effect of nCPAP on the driving simulator and real or near-miss accidents. Studies should adjust for observation time, take into account duration of nCPAP treatment and distance driven per patient, routinely use smart card technologies and convert monitors for objective compliance surveillance.

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