COST-EFFECTIVENESS OF USING CONTINUOUS POSITIVE AIRWAY PRESSURE IN THE TREATMENT OF SEVERE OBSTRUCTIVE SLEEP APNOEA/HYPOPNOEA SYNDROME IN THE UK

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ABSTRACT

Objective: To estimate the cost-effectiveness of using continuous positive airway pressure (CPAP) in the management of patients suffering from severe obstructive sleep apnoea/hypopnoea syndrome (OSAHS), compared to no treatment, from the perspective of the UK’s National Health Service (NHS).

Methods: A Markov model was constructed to assess the cost-effectiveness of CPAP compared to no treatment. The model depicted the management of a 55 year old patient with severe OSAHS as defined by an apnoea-hypopnoea index (AHI) >30 and daytime sleepiness (Epworth scale score >12). The model spans a period of 14 years.

Results: According to the model, 57% of untreated patients are expected to be alive at the end of 14 years compared to 72% of CPAP-treated patients. Untreated patients are expected to cost the NHS £10,645 (95% CI: £7,988; £14,098) per patient over 14 years compared to £9,672 (95% CI: £8,057; £12,860) per CPAP-treated patients. Treatment with CPAP for a period of one year was found not to be a cost-effective option since the cost per QALY gained is expected to be >£20,000, but after two years of treatment the cost per QALY gained is expected to be £10,000 or less and after 13 years of treatment, CPAP becomes a dominant treatment (i.e. more effective than no treatment for less cost).

Conclusion: Within the limitations of our model, CPAP was found to be clinically more effective than no treatment and the cost-effective strategy, from the perspective of the UK’s NHS, after a minimum of 2 years’ treatment.

Keywords: Continuous positive airway pressure, cost, cost-effectiveness, CPAP, obstructive sleep apnoea.

Running title: Cost-effectiveness of CPAP in the treatment of severe obstructive sleep apnoea/hypopnoea syndrome
INTRODUCTION

The nocturnal severity of obstructive sleep apnoea hypopnoea syndrome (OSAHS) is often defined by the number of events per hour. This could be either the number of oxygen desaturation events (oxygen desaturation index) or the number of apnoeas and hypopnoeas (apnoea hypopnoea index (AHl)) with arbitrary thresholds to define mild, moderate and severe disease. The daytime symptom severity of OSAHS is often defined by either subjective sleepiness scales (e.g. Epworth Sleepiness Scale (ESS)), or by objective tests of propensity to sleep (e.g. maintenance of wakefulness test).

Continuous positive airway pressure (CPAP) therapy is the treatment of choice for patients with moderate to severe OSAHS, established through meta-analyses [1,2]. The alternative for patients who cannot tolerate CPAP is, in the majority of cases, “no treatment”. Against this background, this study estimated the cost-effectiveness of using CPAP in the management of patients suffering from severe OSAHS, compared to no treatment, in the UK.
METHODS

Perspective

This analysis estimated the direct healthcare costs and benefits of managing OSAHS over a period of 14 years with and without CPAP, from the perspective of the UK’s National Health Service (NHS).

Data Sources

A systematic literature search was performed using a search term of obstructive sleep apnoea plus one of the following: incidence, prevalence, epidemiology, hypertension, cardiovascular event, myocardial infarction (MI), hypertension, stroke, cerebrovascular event, depression, diabetes, compliance, road traffic accident (RTA), utilities, quality of life, cost-effectiveness, cost-utility, resource utilisation, economic and cost. The search strategy was not limited by year of publication, but only English language papers were included. A manual literature search was also undertaken, based on citations in the published papers.

Economic Model

A Markov model was constructed which depicted the management of a 55 year old patient with severe OSAHS as defined by an AHI >30 and daytime sleepiness (ESS ≥12) (Figure 1). Within the model, the time to the start of treatment with CPAP following the initial outpatient visit or diagnostic sleep study (whichever comes first) is 8.4 months (based on information supplied by the interviewees) and the model spans a period of 14 years. The model comprises the following health states and death:

- Event-free with uncontrolled OSAHS.
- Event-free with controlled OSAHS.
- Stroke.
- Cardiovascular event.
- RTA.
- Survival following stroke, cardiovascular event or RTA.

Within the model, patients can initially move into one of four health states (i.e. event-free, stroke, cardiovascular event or RTA) and patients remain in a state for 1 year at a time before moving to another state. Within the model patients who have a cardiovascular event or RTA in any one year can have a stroke or another cardiovascular event or RTA in a later year and there are no limits on the number of events they can undergo in subsequent years. However, patients who have a stroke can no longer drive, but there are no limits on the number of cardiovascular events or strokes they can undergo in subsequent years. One limitation of the model structure is that it does not consider the impact of OSAHS sufferers having an RTA as a result of being a passenger, particularly stroke patients who can no longer drive. The arrows depict the possible movement of patients between the different health states.
Figure 1: Markov model depicting the management of severe OSAHS.

**Model Inputs - Clinical**

**Cardiovascular Events**

After sleepiness, the principle morbidity of OSAHS relates to the cardiovascular system [3]. However, identification of a clear association between OSAHS and cardiovascular disease has proved challenging [3], although epidemiologic studies have consistently found an association between OSAHS and hypertension [4-6].

A recently published observational (non-randomised) study compared the cumulative risk of fatal and non-fatal cardiovascular and cerebrovascular episodes in OSAHS sufferers over 12 successive years, among those who received and declined CPAP [7]. The study found that patients with severe disease (AHI>30) who accepted CPAP treatment had a significantly reduced cardiovascular risk compared to untreated patients. However, this was an uncontrolled study and patients who decline medical advice and treatments have been shown to have a higher mortality independent of the therapy itself [8]. Therefore, this difference in cardiovascular risk may be an overestimate [8].

The cumulative annual risk of fatal and non-fatal cardiovascular and cerebrovascular events among the patients with severe disease who were treated with and without CPAP in this study [7] was extrapolated using a best fit exponential model from 12 to 14 years, from which the annual incidence was calculated. In a separate study [9], it was reported that the risk of
coronary heart disease and stroke among patients with untreated severe OSAHS was 1.185 and 1.353 respectively. Hence, the ratio of developing coronary heart disease to stroke was 1:1.13. Similarly the authors reported that the ratio among treated patients was 1:1. These ratios were applied to our estimates of the annual incidence of fatal and non-fatal cardiovascular and cerebrovascular events among patients with severe OSAHS, enabling the annual risk of cardiovascular event, stroke, fatality and non-fatality from a cardiovascular and cerebrovascular event to be estimated. These estimates were incorporated into the Markov model and represent the likely maximum effect.

Road Traffic Accidents

Only two studies were found which reported the relative risk of RTAs among OSAHS patients compared to control populations. The first was a case-control study [10] which found that the risk of an RTA among untreated patients was 3 times greater than the risk among control populations, whereas the risk among CPAP-treated patients was the same as that of control populations. In a second study [11], the number of RTAs among OSAHS patients was estimated using a road safety platform. The authors estimated that the risk of an RTA among untreated patients was 2.3 times greater than the risk among control populations, whereas the risk among treated patients was marginally less than that of control populations. By taking the average of the findings of these two studies [10,11] the model assumes that the risk of an RTA among untreated patients was 2.6 times greater than the risk among control populations, whereas the risk among treated patients was the same as that of control populations.

According to the Department of Transport [12] there were 221,751 RTAs in Great Britain in 2002 of which 1.3% resulted in a fatality. The distribution of different severities of RTAs (i.e. slight, serious and fatal) in Great Britain in 2002 and corresponding costs [12] have been incorporated into the model. In the same year there were 25.3 million licensed motor vehicles in Great Britain. Hence, by assuming that all patients are drivers and have a licensed motor vehicle, it was estimated that the risk of an RTA among the control population (and thus treated OSAHS patients) is 0.009 per annum and 0.023 per annum among untreated OSAHS patients.

Compliance

Only four published studies were found which reported the percentage of OSAHS patients who continued using their fixed pressure CPAP device over various periods: 68% over 60 months [13], 85% over 84 months [14], 72% over 24 months [15] and 80% over an unspecified period [16]. The average of these four studies was estimated to be 74%. McArdle et al also reported that the percentage of patients who continued using their CPAP device fell from 84% at the end of the first year to 68% after 4 years, remaining at this level for a further 3 years [13]. This equates to a discontinuation rate of 5% per annum over four years. Similarly, Krieger et al [14] reported that the percentage of patients who continued using their CPAP device fell from 90% after 3 years to 85% after 7 years, equivalent to a discontinuation rate of 1% per annum over four years. The weighted average of these two discontinuation rates was estimated to be 3.8% per annum.

Since the period of the model is >1 year it was assumed that 74% of all patients would continue using their device during the first year of treatment. It was also assumed that 3.8% of patients on CPAP at the beginning of the second year would discontinue using the device during the year and this discontinuation rate would decline exponentially over the remaining
period of the model.

**Model Inputs - Resource Use**

No publications were identified that quantified healthcare resource use for the management of OSAHS in the UK. Therefore, this was estimated using information obtained from interviews with 19 randomly selected clinicians from across the UK who managed large, established sleep services and who collectively see >6,000 new patients with OSAHS per annum. Healthcare resource use attributable to managing severe patients with OSAHS that has been modelled is summarised in Table 1. According to these clinicians, the shelf-life of a CPAP devise within their individual hospitals was 7 years, and this was the time-frame adopted by NICE in their health technology appraisal of CPAP [17].

<table>
<thead>
<tr>
<th>Resource</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of having an initial outpatient visit before a diagnostic sleep study</td>
<td>0.31 (0.11; 0.51)</td>
</tr>
<tr>
<td>Probability of one outpatient visit after a diagnostic sleep study</td>
<td>0.69 (0.49; 0.89)</td>
</tr>
<tr>
<td>Probability having of a home sleep study</td>
<td>0.75 (0.59; 0.90)</td>
</tr>
<tr>
<td>Probability of having a home titration study</td>
<td>0.99 (0.97; 1.00)</td>
</tr>
<tr>
<td>Probability of having a titration study in hospital</td>
<td>0.04 (0; 0.05)</td>
</tr>
<tr>
<td>Probability of using CPAP (fixed) for titration</td>
<td>0.19 (0.01; 0.36)</td>
</tr>
<tr>
<td>Probability of using CPAP (auto) for titration</td>
<td>0.81 (0.64; 0.99)</td>
</tr>
<tr>
<td>Probability of seeing a consultant during the titration phase</td>
<td>0.40 (0.05; 0.52)</td>
</tr>
<tr>
<td>Probability of seeing a specialist nurse during the titration phase</td>
<td>1.00 (0.53; 1.00)</td>
</tr>
<tr>
<td>Probability of seeing a technician during the titration phase</td>
<td>0.48 (0.10; 0.93)</td>
</tr>
<tr>
<td>Probability of having a humidifier</td>
<td>0.38 (0.22; 0.50)</td>
</tr>
<tr>
<td>Probability of switching from fixed to auto CPAP in the second year</td>
<td>0.06 (0.04; 0.07)</td>
</tr>
<tr>
<td>Probability of switching from fixed to auto CPAP in subsequent years</td>
<td>0.01 (0; 0.02)</td>
</tr>
<tr>
<td>Probability of a non-compliant patient returning their machine</td>
<td>0.75 (0.50; 1.00)</td>
</tr>
<tr>
<td>Probability of having a follow-up visit within 3 months of starting CPAP</td>
<td>0.75 (0.50; 1.00)</td>
</tr>
<tr>
<td>Probability of having a follow-up visit within 4-6 months of starting CPAP</td>
<td>0.75 (0.75; 1.00)</td>
</tr>
<tr>
<td>Probability of annual follow-up visits after starting CPAP with a consultant</td>
<td>0.13 (0; 0.27)</td>
</tr>
<tr>
<td>Probability of annual follow-up visits after starting CPAP with a specialist nurse</td>
<td>0.61 (0.33; 0.79)</td>
</tr>
<tr>
<td>Probability of annual follow-up visits after starting CPAP with a technician</td>
<td>0.26 (0.09; 0.54)</td>
</tr>
<tr>
<td>Probability of a deceased patient’s machine being returned</td>
<td>0.90 (0.75; 1.00)</td>
</tr>
</tbody>
</table>

**Table 1: Estimates of healthcare resource use** (95% confidence limits in parentheses).

Unit costs at 2005/06 prices that have been incorporated into the model were obtained from the Departments of Health and Transport [12, 18]. The costs of CPAP, humidifier and mask used in the model [19] are the List Prices without the application of any discounts often enjoyed by the NHS. The hospital cost of an episode of MI [20] and the cost of home-based cardiac rehabilitation for the first year following an MI [21] have been used as proxies for the cost of managing a cardiovascular event.

**Model Inputs – Health-Related Quality of Life (HRQoL) and Utilities**

A Spanish study obtained utility values for different health states from OSAHS patients who completed the EQ-5D questionnaire before and after they received CPAP treatment [9]. In the
absence of any other data, these utilities (0.738 for untreated OSAHS, 0.811 for treated OSAHS, 0.590 for non-fatal stroke in untreated OSAHS patients, 0.649 for non-fatal stroke in treated OSAHS patients, 0.664 for non-fatal cardiovascular event in untreated OSAHS patients, 0.730 for non-fatal cardiovascular event in treated OSAHS patients, 0.701 (estimated) for non-fatal RTA in untreated OSAHS patients and 0.771 (estimated) for non-fatal RTA in treated OSAHS patients) were applied to the health states in our Markov model, enabling patients’ level of health gain in terms of the expected number of quality-adjusted life years (QALYs) over 14 years to be estimated.

**Model Outputs**

The measures of clinical effectiveness were defined as:
1. The expected percentage of surviving patients at 14 years.
2. The expected percentage of event-free surviving patients at 14 years.
3. The expected number of QALYs at 14 years.

The model also estimated the cumulative risk of having a stroke, cardiovascular event and RTA over 14 years. By incorporating the unit costs into the different states within the Markov model, the expected direct healthcare costs over 14 years were estimated. Costs and consequences that were incurred by patients in the second and subsequent years of the model were discounted by 3.5% in accordance with current UK guidelines [22].

**Cost-Effectiveness Analyses**

The incremental cost-effectiveness of CPAP relative to no treatment was calculated as the difference between the expected cost of the two strategies over 14 years ÷ the difference between the expected outcomes between the two strategies over 14 years. When the outcome was the probability of survival, the incremental cost-effectiveness of CPAP relative to no treatment was defined as the cost per life-year gained. When the outcome was the expected number of QALYs, the incremental cost-effectiveness of CPAP relative to no treatment was defined as the cost per QALY gained. If a treatment resulted in improved outcome for less cost it was defined as a “dominant treatment”.

**Sensitivity Analyses**

Probabilistic sensitivity analyses were undertaken by simultaneously varying all the probabilities, utilities, unit costs and resource use values within the model. The probabilities and utilities were varied randomly according to a beta distribution and the resource use estimates and unit costs were varied randomly according to a normal distribution. Deterministic analyses were performed to assess the impact of varying individual parameters within the model.
RESULTS

Expected Outcomes of Care

According to the Markov model, 57% of untreated patients are expected to be alive at the end of 14 years compared to 72% of CPAP-treated patients. Moreover, 30% of untreated patients are expected to have survived event-free over 14 years compared to 58% of CPAP-treated patients. The expected changes in outcomes associated with CPAP over 14 years are summarised in Table 2.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No treatment</th>
<th>CPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td>0.57 (0.49; 0.65)</td>
<td>0.72 (0.66; 0.78)</td>
</tr>
<tr>
<td>Cardiovascular event</td>
<td>0.35 (0.20; 0.53)</td>
<td>0.19 (0.09; 0.27)</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.39 (0.23; 0.60)</td>
<td>0.20 (0.08; 0.31)</td>
</tr>
<tr>
<td>RTA</td>
<td>0.24 (0.21; 0.28)</td>
<td>0.17 (0.14; 0.19)</td>
</tr>
<tr>
<td>Event-free survival</td>
<td>0.30 (0.13; 0.46)</td>
<td>0.58 (0.47; 0.70)</td>
</tr>
<tr>
<td>QALYs</td>
<td>7.22 (6.48; 7.93)</td>
<td>8.09 (7.17; 8.44)</td>
</tr>
</tbody>
</table>

Table 2: Expected outcomes associated with severe OSAHS after 14 years of treatment with CPAP or no treatment. (95% confidence limits in parentheses).

Expected Healthcare Costs

According to the Markov model, untreated patients are expected to cost the NHS £10,645 (95% CI: £7,988; £14,098) per patient over 14 years compared to £9,672 (95% CI: £8,057; £12,860) per CPAP-treated patient (Table 3). Hence, use of CPAP over 14 years is expected to:

- Increase the probability of survival by 25%.
- Decrease the relative risk of having a cardiovascular event by 46%.
- Decrease the relative risk of having a stroke by 49%.
- Decrease the relative risk of having an RTA by 31%.
- Increase the probability of event-free survival by 92%.

for a cost-reduction of £973 (95% CI: -£1,983; £1,508) over 14 years.

The total discounted cost for the device, mask, humidifier and sundries was estimated to be £1,795 per patient over 14 years. This cost reflects an expectation that the CPAP device would be returned in 75% and 90% of cases where patients either do not comply or die, respectively.

The cost associated with managing stroke was found to be the primary cost driver in both groups. The secondary cost driver in untreated patients was found to be the cost associated with managing RTAs, whereas in CPAP-treated patients it was the cost of the device itself.
### Table 3: Expected healthcare costs (at 2005/06 prices) over 14 years following no treatment or CPAP. (Percentage of total expected cost is in parentheses).

<table>
<thead>
<tr>
<th>Resource</th>
<th>No treatment</th>
<th>CPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinician visits for OSAHS</td>
<td>0.00 (0%)</td>
<td>682.22 (7%)</td>
</tr>
<tr>
<td>Devices</td>
<td>0.00 (0%)</td>
<td>1,794.52 (19%)</td>
</tr>
<tr>
<td>Diagnostic sleep studies</td>
<td>0.00 (0%)</td>
<td>123.60 (1%)</td>
</tr>
<tr>
<td>Resources required to manage cardiovascular events</td>
<td>1,044.67 (10%)</td>
<td>564.50 (6%)</td>
</tr>
<tr>
<td>Resource required to manage strokes</td>
<td>7,203.58 (68%)</td>
<td>4,961.12 (51%)</td>
</tr>
<tr>
<td>Resources required to manage road traffic accidents</td>
<td>2,396.77 (23%)</td>
<td>1,546.29 (16%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10,645.02 (100%)</td>
<td>9,672.25 (100%)</td>
</tr>
</tbody>
</table>

The cumulative NHS costs associated with OSAHS management accrue over time. The cost of managing patients with CPAP becomes less than that of patients not receiving CPAP treatment by the thirteenth year due to the greater number of cardiovascular events, strokes and RTAs among untreated patients.

### Cost-Effectiveness Analyses

The cost-effectiveness analyses of CPAP relative to no treatment show that CPAP affords the NHS a dominant treatment. However, Figure 2 illustrates that treatment of CPAP for a period of one year is not a cost-effective option since the cost per QALY gained is >£20,000. However, after two years of treatment the cost per QALY gained is £10,000 or less and after 13 years of treatment, CPAP becomes a dominant treatment.

![Figure 2: Cumulative cost per QALY gained over 14 years.](http://thorax.bmj.com/)

-£5,000     £0     £5,000     £10,000     £15,000     £20,000     £25,000     £30,000     £35,000

-£5,000     £0     £5,000     £10,000     £15,000     £20,000     £25,000     £30,000     £35,000

<table>
<thead>
<tr>
<th>Time (years)</th>
<th>Cumulative cost per QALY gained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>£30,000</td>
</tr>
<tr>
<td>2</td>
<td>£25,000</td>
</tr>
<tr>
<td>3</td>
<td>£20,000</td>
</tr>
<tr>
<td>4</td>
<td>£15,000</td>
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<tr>
<td>5</td>
<td>£10,000</td>
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<tr>
<td>6</td>
<td>£5,000</td>
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<tr>
<td>7</td>
<td>£0</td>
</tr>
<tr>
<td>8</td>
<td>£5,000</td>
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<td>9</td>
<td>£10,000</td>
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<td>10</td>
<td>£15,000</td>
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<td>11</td>
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<td>12</td>
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<tr>
<td>13</td>
<td>£30,000</td>
</tr>
<tr>
<td>14</td>
<td>£35,000</td>
</tr>
</tbody>
</table>
Sensitivity Analyses

Probabilistic sensitivity analyses demonstrated that CPAP has a 0.99 probability of being cost-effective for a threshold of £20,000 per QALY.

The model incorporated clinical outcomes pertaining to cardiovascular and cerebrovascular events and RTAs from disparate publications. The base case analyses were repeated by removing these outcomes from the model. Even if all cardiovascular and cerebrovascular events and RTAs were excluded from the model, the cost per QALY gained with CPAP relative to no treatment would be £4,592 (95% CI: -£1,236; £5,112). Hence, CPAP still affords the NHS a cost-effective technology.

Deterministic sensitivity analyses revealed that changes in some input values have an effect on the relative cost-effectiveness of CPAP. In particular, the proportion of patients who continue using CPAP, the risk of having a cardiovascular/cerebrovascular event, the risk of having an RTA, the utility for treated and untreated OSAHS, the cost of managing a non-fatal RTA and the cost of managing stroke rehabilitation. Nevertheless, CPAP ceases to afford the NHS a dominant treatment only when:

- The proportion of patients who continue using CPAP falls below 60% in the first year of treatment.
- The relative risk of having a cardiovascular/cerebrovascular event falls to 60% below the base case value.
- The cardiovascular event:stroke ratio among untreated OSAHS patients rises above 1:0.9

However, in all instances the cost per QALY gained with CPAP is <£5,000. The model was insensitive to changes in other model inputs. In particular, the cost-effectiveness of CPAP only changed marginally when changes were made to (1) the time to the start of treatment and (2) all the utility values except that for untreated OSAHS.

The base-case model assumes that the shelf-life of CPAP within the NHS is 7 years. However, changing the shelf-life to five years, has negligible effect on the cost-effectiveness of CPAP. The expected cost to the NHS would rise by £160 to £9,833 (95% CI: £8,229; £13,060) per patient over 14 years. Nevertheless, CPAP is still expected to afford the NHS a dominant treatment with a cost per QALY of -£942 (95% CI: -£2,507; £4,173).
DISCUSSION

The model was constructed using information obtained from disparate publications, including the incidence of cardiovascular and cerebrovascular events reported by Marin et al in their uncontrolled observational study [7]. The rationale for using this particular study was that patients were followed for 12 years, which was the longest study we could find. Such observational studies have inherent weaknesses such as a placebo effect, a Hawthorne effect and regression to the mean. Notwithstanding this, the findings of Marin et al were concordant with those of Peker et al [23]. Published randomised trials have reported the effect of CPAP on blood pressure. Accordingly, we could have used Framingham risk equations to provide a link between blood pressure and the incidence of fatal and non-fatal cardiovascular events in a hypothetical cohort of patients. However, we considered that using clinical outcomes from a cohort of patients with OSAHS based on actual clinical practice would lead to fewer assumptions and a model that was more representative of the “real world”. Additionally, the analysis was unable to consider the impact of other co-morbidities, such as diabetes and depression, due to a lack of published evidence.

Our model is subject to several other limitations. Since the clinical basis of the model was disparate published studies and Government statistics, the model may not reflect clinical outcomes observed in clinical practice among a cohort of patients over a period of successive years. Moreover, it was not possible to model the management of moderate OSAHS due to the lack of published clinical data required to inform such modelling. We were unable to find any published studies assessing health care resource utilisation associated with managing OSAHS in the UK. Hence, this was obtained from interviews with 19 clinicians from across the UK who collectively see >6,000 new patients with OSAHS per annum. Utilities were derived from a Spanish population and these may not be the same as those of a UK population. This gives rise to uncertainty regarding the applicability of these values to a UK study, although sensitivity analyses showed that changing most of these values had minimal impact on the cost-effectiveness of CPAP. The model used resource estimates and utility values for the ‘average patient’ and did not take into account such factors as age, gender, suitability of patients for different treatments, other disease-related factors, patients’ preferences and level of clinicians’ skills.

The model only considered direct healthcare costs borne by the NHS and not those borne by other Government departments, such as social services costs for rehabilitating stroke patients and the wider societal costs of RTAs (e.g. a fatal RTA can cost >£1 million [24]). Moreover, the model excluded some primary care costs such as those associated with managing sleepiness, RTAs and cardiovascular events and this may have underestimated the health economic benefits of CPAP. Also excluded is the cost of any medication including that of antihypertensives required to manage hypertension arising from OSAHS. Additionally, the model excluded costs incurred by patients and indirect costs borne by patients or society including the societal cost of sleepiness. If all these costs were factored-in, the health economic benefits of CPAP therapy would inevitably be much greater.

Notwithstanding these limitations, our model indicated that treatment with CPAP for a period of one year is not a cost-effective option since the cost per QALY gained is >£20,000. However, NICE considers that a technology that has a cost-effectiveness of <£20,000 per QALY potentially affords an effective use of NHS resources [25]. Hence, use of CPAP over 14 years is expected to afford the NHS a cost-effective technology, since after two years’ treatment with CPAP the cost per QALY gained is <£10,000 and after 13 years’ treatment,
CPAP becomes dominant. These findings are concordant with those from four other studies, which all found CPAP to be a cost-effective treatment [9, 26-28]. Sensitivity analyses demonstrated that the relative cost-effectiveness of CPAP is sensitive to continuation rates. Thus, any intervention that improves long-term take-up rates, such as better patient education, is worth employing.

In conclusion, within the limitations of our model, CPAP was found to be clinically more effective than no treatment and the cost-effective strategy from the perspective of the NHS in the UK, after a minimum of 2 years’ treatment.
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