Office of Health Economics Consulting

Consulting Report for
the British Lung Foundation

British Lung Foundation

Obstructive Sleep Apnoea Health Economics Report

Juan Carlos Rejón-Parrilla, Martina Garau and Jon Sussex

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CONTENTS

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EXECUTIVE SUMMARY

Identifying OSA in the UK

- Obstructive Sleep Apnoea (OSA) is a sleep-related condition. Someone with OSA experiences repeated temporary cessations of breathing during sleep because of a narrowing or closure of the pharyngeal airway during sleep. OSA, when untreated, deprives people of a healthy sleep, which can cause severe daytime sleepiness.
- Risk factors commonly associated with OSA are: gender (more common in men than women), age (more common in older age), hypertension, diabetes, and obesity. On this basis, it is likely that the prevalence of OSA will rise in the coming years, particularly due to an increasing prevalence of obesity and the increasing age of the UK population.
- There is uncertainty about the number of adults in the UK who have OSA, as the majority of cases remain undiagnosed. Based on data in the literature, we estimated that in the UK 1.5 million adults have OSA, although only around 330,000 are currently diagnosed and treated.

Consequences of OSA and current NICE recommendations for treatment

- If untreated, OSA deprives patients of a healthy sleep and can have other negative consequences. It has been shown that these effects can lead to increased road traffic accident rates, cardiovascular events, and strokes.
- There are a number of treatments available for OSA patients at different level of severity (mild, moderate and severe). The National Institute for Health and Care Excellence (NICE) appraised, in 2008, the use of continuous positive airway pressure (CPAP) compared to lifestyle management and dental devices for the treatment of adults with OSA. Treating OSA with CPAP was found to be cost-effective, as it reduces daytime sleepiness amongst people with OSA, and also offers good value for money. Its cost effectiveness was estimated to be below £5,000 per quality-adjusted life-year gained (QALY) which is lower than many other interventions recommended by NICE and NICE's incremental cost effectiveness ratio threshold range (£20,000 to £30,000).
- However, according to the latest evidence available, since the publication of the NICE advice, the proportion of people with OSA that do not have access to the most appropriate treatment is still very high (up to 85%). Evidently there are difficulties in identifying patients and referring them to the right specialist, and in implementing NICE's recommendation at the local level.

Assessing the total direct effects of treating OSA

- There is evidence in the literature showing that treating OSA can generate direct health benefits to OSA patients and reduce costs incurred within the NHS when compared to no treatment. Guest et al. (2008)[1] estimated that using CPAP over a period of 14 years could result in savings to the NHS close to £1,000 per patient, and health benefits to patients, including reduction in risks of strokes, cardiovascular events, and road traffic accidents. This led to an increase of the

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[1] Guest, J. F., Helter, M. T., Morga, A., & Stradling, J. R. (2008). Cost-effectiveness of using continuous positive airway pressure in the treatment of severe obstructive sleep apnoea/hypopnoea syndrome in the UK. *Thorax*, 63(10), pp.860-865.

probability of survival after 14 years of treated patients by 25% as compared to non-treated patients (Guest et al., 2008).

- In addition to direct health benefits to patients and costs/savings to the NHS that are traditionally considered by NICE in its technology appraisals, treating OSA produces wider economic benefits, including increased productivity due to reduced sleepiness at work, and also quality of life improvements for people close to OSA patients (their bed partners).
- Considering only direct benefits, we estimate the NHS in the UK would be saving a total of £55 million and producing 40,000 QALYs annually if all people with moderate to severe OSA (45% of the total OSA patient population) were diagnosed and treated with CPAP, relative to none being diagnosed and treated. These estimates incorporate the estimated reduction in road traffic accidents, cardiovascular events and strokes, and their positive consequences for patients' length and quality of life.
- Relative to the current estimated rate of OSA patients treated across the UK (22% of OSA patients, around 330,000 in total), increasing diagnosis and treatment rates to 45% of OSA patients could yield **annual savings of £28 million** and **20,000 extra QALYs**.
- If everyone estimated to have moderate to severe OSA in the UK were treated, approximately 40,000 additional road accidents could be prevented each year relative to the current situation. As some of these accidents result in injury or even fatality, the likely health gains are considerable.

Distribution of services and other challenges in the provision of care for OSA

- The estimated risk of having OSA varies across regions in the UK. However, there is a mismatch between the geographical distribution of need and the distribution of services in the UK, which might lead to inequity, where the same treatment may not be available to everyone with the same need.
- We identified areas that merit further research in order to improve access to the most cost effective diagnosis and treatments in the management of OSA. For example, despite existing evidence highlighting the role for oral devices in people with mild OSA and in people not suitable for treatment with CPAP, there remains uncertainty around the cost effectiveness of these interventions in other patient populations. More robust evidence is also needed around: the causality between OSA and certain conditions such as diabetes, hypertension, and vascular diseases; and the assessment of current use of CPAP across UK and of the reasons for slow uptake of NICE guidance.
- The evidence found in the literature demonstrates that OSA patients, the NHS and the wider society in the UK have not yet obtained all of the economic and health benefits that could be achieved. An increase in the rate of uptake of CPAP could double the savings to the NHS and the health benefits to patients compared to the current situation.

1. INTRODUCTION

The British Lung Foundation

The British Lung Foundation (BLF) is the UK's lung charity. It promotes better understanding of lung disease and campaigns for positive change in the nation's lung health. Since 2011, the BLF has been campaigning to improve awareness of obstructive sleep apnoea (OSA) and to improve service provision for those affected. The BLF has commissioned OHE Consulting to prepare a report on the health economics of OSA in adults in the UK.

Obstructive sleep apnoea (OSA)

Someone with OSA experiences repeated temporary cessations of breathing during sleep because of a narrowing or closure of the pharyngeal airway, resulting in episodes of brief awakening from sleep to restore normal breathing. OSA, when untreated, deprives people of a healthy sleep, which can cause daytime sleepiness. The symptoms of OSA include loud snoring, breathing pauses in sleep, and excessive daytime sleepiness. Excessive daytime sleepiness can adversely affect cognitive function, mood and quality of life of patients and of their partners. There is an increased risk of road traffic accidents associated with the sleepiness caused by OSA and an increased risk of cardiovascular disease and stroke due to the higher blood pressure associated with OSA (NICE, 2008a).

Objective of this report

The objective of this report is to analyse and present the economic implications of OSA based on the current options for OSA care for adults in the UK. We bring together the published evidence to demonstrate the total health and cost consequences of under-treating OSA, and the possible benefits that more appropriate access to treatment could generate in the UK, from the perspective of patients, the NHS and society generally. We provide estimates of the reductions in ill health and potential savings in costs that diagnosis and treatment could bring. We present the evidence around the current status of OSA treatment in the UK, which highlights the need for change so that the NHS can fully meet the needs of people with OSA, while respecting the economic principles of effectiveness, equity and efficiency that health care commissioners and service planners are obliged to follow.

There are costs to UK society beyond the direct costs of treating OSA for the NHS, and savings beyond those benefitting the NHS. Those will be discussed separately.

Another objective of this report was to form the basis for the content of a toolkit to be used by local NHS commissioners and planners of health care across the UK in their decision making.

Report structure

The report follows this structure. After a concise description of our method of working (Chapter 2), we describe the prevalence of OSA in the UK, linking it to the availability of services to identify and treat it (Chapter 3). We then set out in detail: the available options for the diagnosis and the treatment of OSA (Chapter 4); the consequences of failure to treat and the total benefits and cost consequences of treating OSA with the continuous positive airway pressure (CPAP) devices, which has been recommended by the National Institute for Health and Care Excellence (NICE), as compared to not treating OSA in the UK, from an NHS perspective (Chapter 5). We discuss separately in the same chapter the potential gains that the treatment can generate from a societal perspective (for example reduce patients' absence from work).

We then apply our estimates of total cost savings to the NHS and health benefits to the patients in the UK to individual UK countries and outline key challenges faced in the four countries for the provision of adequate OSA service (Chapter 6).

In Chapter 7 we compare the cost to the NHS of treating OSA with the costs of some other diseases, and compare the cost-effectiveness of CPAP with that of other health care technologies evaluated by NICE. Our conclusions are in Chapter 8. Finally, we point out areas where further research would be valuable (Chapter 9).

2. METHOD

We reviewed literature published in peer reviewed journals and in the grey literature about the economics of OSA in the UK and internationally. We used three sources to identify relevant published evidence: an initial collection of papers on OSA provided by BLF, a literature search and interviews with experts.

Our starting point was a list of key papers provided to us by the BLF. This was extended to include other references that looked relevant that were cited in these articles. We undertook targeted searches to identify additional papers, including grey literature. We created a database of articles and other documents to group the literature in themes reported as chapter headings and review it accordingly.

Our review was as comprehensive as possible within the budget available and was focused on obtaining papers that could provide us with quantitative estimates of benefits and costs. We prioritised UK evidence, but when non UK publications presented relevant evidence we included this. We prioritised NHS/NICE evidence over other sources.

We used Excel when calculations were needed to adapt data presented in the literature.

Following the initial selection and screening of the most relevant papers, we developed a framework capturing key impacts of treating and not treating OSA (this is presented in the Appendix) and discussed this with two clinical experts in OSA, identified by the BLF. The experts commented on our framework and indicated important published literature to consider.

Before finalising this report, drafts were reviewed by the BLF's OSA Working Group of OSA experts. All assumptions used in this report were validated by the BLF's OSA Working Group of experts.

3. IDENTIFYING OSA IN THE UK - RISK FACTORS AND PREVALENCE

Geographical distribution of risk of OSA

The risk of having OSA in the UK has been estimated as part of the BLF's OSA project (Steier et al., 2014). The study by Steier et al. (2014) uses a dataset that estimates the relative population risk of OSA at a geographical level relevant to local commissioners of NHS funded health care in England, Northern Ireland, Scotland and Wales. Local health authority boundaries in each one of the four countries are: Clinical Commissioning Groups (CCGs) in England , Health and Social Care Trusts (HSCTs) in Northern Ireland, NHS Health Boards (HBs) in Scotland and Local Health Boards (LHBs) in Wales. The dataset presents an estimate of the weighted prevalence of OSA in the UK based on the geographical distribution of five risk factors commonly associated with OSA: obesity, gender (more common in men than women), age (more common in older age), hypertension and diabetes. Figure 1, from Steier et al. (2014), shows the resulting map illustrating where risk of OSA is highest or lowest, by quintile of risk. Using these estimates of weighted risk of OSA and a national estimate of OSA prevalence in the UK it is possible to calculate the estimated prevalence of OSA for each local health authority area.

Figure 1 also shows the locations of NHS sleep clinics, and colour codes them according to the type of sleep study they undertake there. It is clear that the availability of services does not always follow the estimated risk of OSA in the UK. Steier et al. (2014) highlighted that there is a scarcity of sleep services in rural areas, where population tends to be older and more likely to have OSA than the younger population in urban areas.

Although there is no broad consensus on the reasons underpinning the high number of undiagnosed people with OSA in the UK, the mismatch between the geographical distribution of need and the distribution of services (sleep centres) in the UK has been highlighted in the literature (Steier et al., 2014) as a potential confounder. This undermines horizontal equity in the delivery of health care, which requires that patients with equal need receive equal treatment (Wagstaff et al., 1989).

Prevalence of OSA in the UK

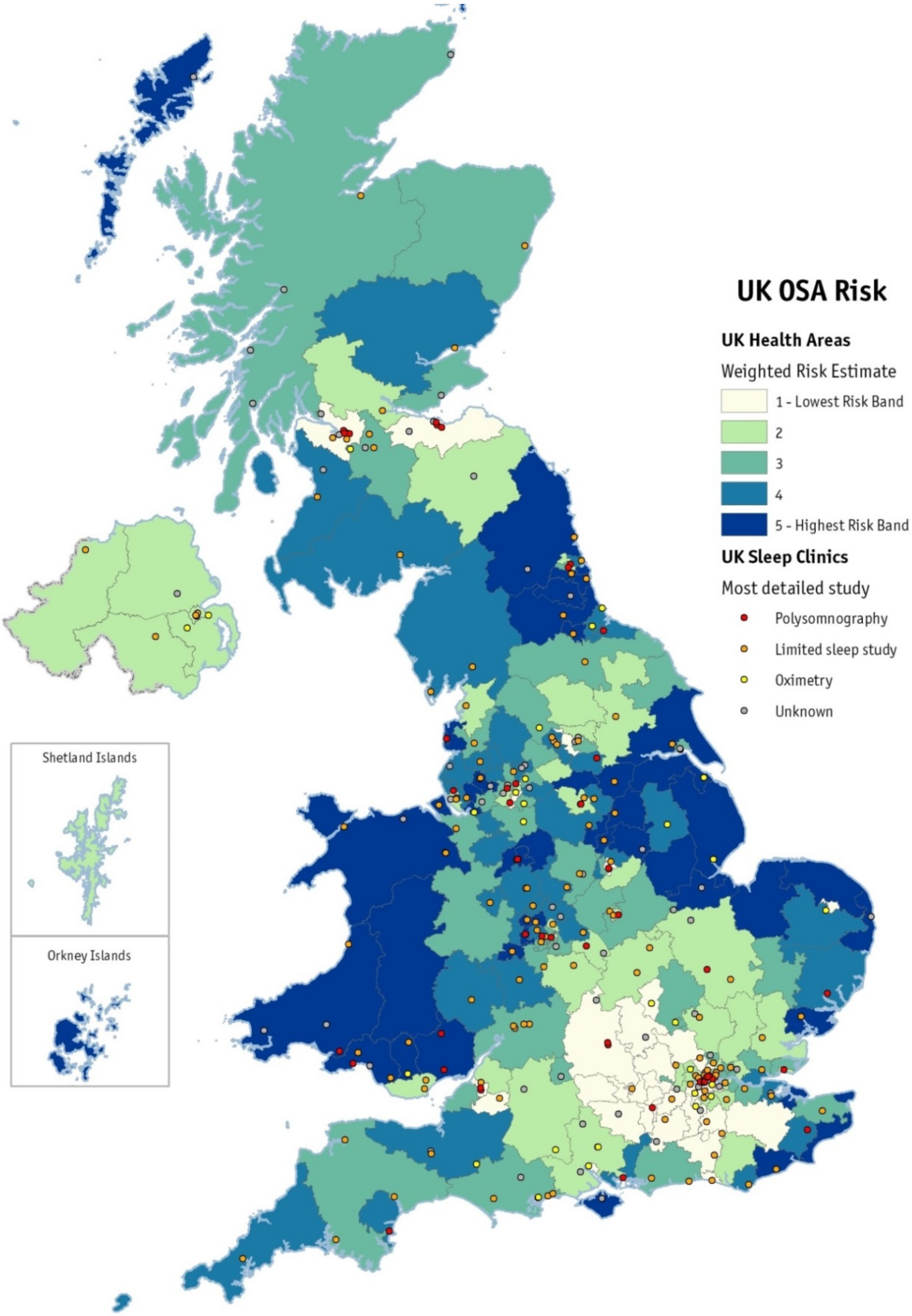
Recent evidence suggests that 85% of people with OSA in the UK are undiagnosed and therefore untreated (NHS North of England Specialised Commissioning Group, 2012).

It is also estimated that 1.4 million people of all ages, including children, live with undiagnosed sleep apnoea in the UK and another 400,000 people are estimated to be diagnosed with this condition, giving a total of 1.8 million people with OSA of all ages (Moore, 2012). Adults make up 82.4% of the UK population according to the 2011 Census. Therefore, we estimated that the number of adults with OSA in the UK who are being treated is around 330,000, out of a total population of adults with OSA of around 1.5 million. We will use those estimates when assessing the total costs and benefits of treating OSA in the UK in Chapter 5.

We acknowledge that OSA can affect children. It is estimated that up to 1 in 30 children could have the condition. However, given the paucity of evidence on the treatment of this population we did not consider it in our analysis.

Additionally, Moore (2012) pointed out that the experience of the US suggests that the prevalence of OSA in the UK will increase in coming years as the prevalence of obesity rises. Age is also amongst the risk factors for OSA. The increasing age of the UK population is therefore an additional factor that is likely to contribute to a higher prevalence of OSA in the UK in the near future.

Figure 1. Weighted accumulated prevalence estimates of OSA and availability of Sleep Clinics in the UK



Notes: Areas are displayed as health authority area. The legend indicates the relative risk band in quintiles (1–5), darker colours indicating higher predicted prevalence estimate.
Sources: Steier et al. (2014) and British Lung Foundation (2012).

4. TACKLING OSA

Diagnostic strategies

The diagnosis of OSA has not received attention to date from the NICE guidelines programme or from the NICE diagnostics assessment programme. Nevertheless, there is a broad spectrum of strategies available in the UK for the identification of patients with OSA. The traditional approach of observation of patient history, which is available to all practitioners, is arguably the most important tool for the diagnosis of OSA (Thurnheer, 2007; 2011). Subsequently, there is a range of other strategies for which there is evidence of effectiveness, ranging from home-based unattended portable monitoring for diagnosis and autotitrating CPAP (autoPAP) (Rosen et al., 2012), to limited sleep studies and oximetry (Scottish Intercollegiate Guidelines Network, 2003), to polysomnography (Pietzsch et al., 2011). The use of other diagnostic strategy with higher costs would need to provide higher diagnostic accuracy to represent an efficient use of resources.

No economic evidence was found on those diagnostic strategies in the UK context. Guest et al. (2008) produced an estimate of the cost of treated and untreated patients to the UK NHS which included direct costs of identifying patients, but assessing the efficiency of different diagnostic strategies was not the primary objective of the study. Pietzsch et al. (2011) suggested that polysomnography followed by CPAP is likely to be the most efficient strategy from the US payer perspective (Pietzsch et al., 2011). However, the US health care system is very different from the UK one, especially on the cost side, which makes it difficult to generalise from those results. In addition, since the publication of this study US insurers have switched to limited sleep studies given the costs associated with polysomnography.

Patient subgroups

The focus of this report is on Obstructive Sleep Apnea Hypopnea Syndrome as defined in the NICE TA 139. In the rest of the report we will refer to this as OSA.

The severity of OSA can range from mild, through moderate to severe measured with apnoea hypopnoea index (AHI) and daytime sleepiness (Epworth Sleepiness Scale score[2]). OSA is classified as severe if the patient has an AHI over 30, moderate if he/she has an AHI between 15 and 30, and mild is he/she has an AHI between 5 and 14.

In the NICE costing template for England and Wales for the appraisal of CPAP (NICE, 2008b) it is estimated that mild cases accounts for 10% of the OSA population treated with CPAP, and moderate and severe cases the remaining 90%.

Out of the total OSA patient population, we estimated that 55% has mild and 45% has moderate to severe OSA (Burgess et al., 2013; Young et al., 1993). This was based on two studies:

[2] ESS = Epworth Sleepiness Scale. The ESS ranges from 0 – 24, being 0-10 Normal range; 10-12 Borderline; and 12-24 Abnormal

- An Australian study (Burgess et al., 2013) showed that in a group of over 1,000 recruited people with BMI>30 and/or Type 2 diabetes and/or hypertension and/or ischaemic heart disease, 38% had mild OSA, 17% moderate and 16% severe. If those proportions are applied to the total population with OSA the ration 38:17:16 translates to 54% of OSA cases having mild OSA and 46% having moderate or severe.
- This is in line with the ratio that we can derive from another study (Young et al., 1993) where it is reported that in a random sample of just over 600 individuals 10% had an AHI of 5-15, 4% had an AHI of 15-30 and 4% had an AHI>30. If we apply this ratio (10:4:4) to the total population we obtain a split of 56% of OSA cases being mild and 44% moderate or severe.

Treating OSA - available interventions

CPAP

NICE appraised the following three interventions to identify the most cost-effective strategy to treat patients with OSA: conservative management, dental devices and CPAP (NICE, 2008a). NICE deemed CPAP to be effective and a cost-effective use of NHS resources, and recommended its use as the treatment option for adults with moderate or severe symptomatic obstructive sleep apnoea/hypopnoea syndrome.

For patients with mild OSA, NICE recommended the use of CPAP only under the following defined circumstances: “CPAP should only be available as a treatment option for people with mild symptomatic OSAHS if lifestyle advice and other relevant treatment options have been unsuccessful or are considered inappropriate” (NICE, 2008a).

The NICE Appraisal Committee considered evidence presented by the academic group and by the manufacturer, and noted that in both analyses the base-case incremental cost-effectiveness ratios (ICERs) of CPAP compared with lifestyle management and no treatment respectively were below £5,000 per quality-adjusted life-year (QALY) gained. They also noted that, even excluding cardiovascular events and road traffic accidents (RTAs), the cost per QALY of CPAP for moderate and severe OSA was below £10,000 per QALY gained. The sub-group analysis available for mild OSA excluded RTAs and resulted in an estimate of £20,585 per QALY gained (for CPAP compared with lifestyle management).This was the key driver for the restricted recommendation of CPAP for mild OSA.

Oral devices

These are appliances designed to alter upper airway patency. They include mandibular repositioners, tongue retaining devices, and palatal lifting devices (Food and Drug Administration, 2002).

The evidence found on the effectiveness of oral devices present mixed results and there seems to be a lack of consensus as to the most appropriate use of these interventions in OSA patients with different level of severity.

In the NICE TA 139, oral devices were dominated by CPAP in moderate OSA patients and no data was found for comparisons in mild or severe OSA. On this basis, NICE guidance indicated that “dental devices may be a treatment option in moderate disease but some uncertainty remains" and "the effectiveness of dental devices compared to CPAP in mild and severe disease populations is unclear" (NICE, 2008a).

The Scottish Intercollegiate Guidelines Network (SIGN) has highlighted the benefits of treating mild to moderate OSA with oral devices as variable, from small to very large, measured by the apnoea-hypopnoea index (AHI) (Scottish Intercollegiate Guidelines Network, 2003).

More recent UK evidence, however, suggests that oral devices can be considered effective and also cost-effective compared to no treatment in mild to moderate OSA (Quinnell et al., 2013). Vanderveken and Hoekema (2010) suggest that oral devices are beneficial for a range of patient populations, including:

- snorers without excessive sleepiness,
- some patients with mild to moderate OSA,
- patients with severe OSA who have failed with CPAP,
- patients who need a temporary alternative to CPAP, and
- patients who need a rescue treatment after surgery failure.

A recent study involving less than 150 patients supports these conclusions by showing that 55.7% of OSA patients approached preferred oral appliances compared to 41.5% who preferred CPAP (only 2.8% preferred no treatment) (Krucien et al., 2014). Additionally, other evidence suggests that although oral devices are less cost-effective than CPAP they are still cost-effective compared to no treatment and should be considered as an alternative for patients who present problems of adherence to CPAP (Sadatsafavi et al., 2009). More generally, Li et al. (2013) noted that the milder the symptoms of OSA, the less likely are the subjects to accept CPAP.

We conclude that oral devices could be an effective and convenient treatment for OSA in all level of severity, particularly in mild patients and patients not suitable for CPAP. However, more data is needed to demonstrate its cost effectiveness in other populations.

Lifestyle changes

The NHS Choices website recommends lifestyle changes and/or oral devices for the treatment of mild sleep apnoea (NHS Choices, 2012).

The evidence around treating OSA exclusively with lifestyle advice is not conclusive enough to delay the use of CPAP in patients diagnosed with this condition. A Cochrane Review concluded that there is no evidence that simple non-invasive lifestyle changes may improve sleep apnoea or its consequences (Shneerson and Wright, 2001). Additionally, there is evidence suggesting that delayed management of OSA might have a negative impact on patients' health particularly in more severe patients (Pelletier-Fleury et al., 2004).

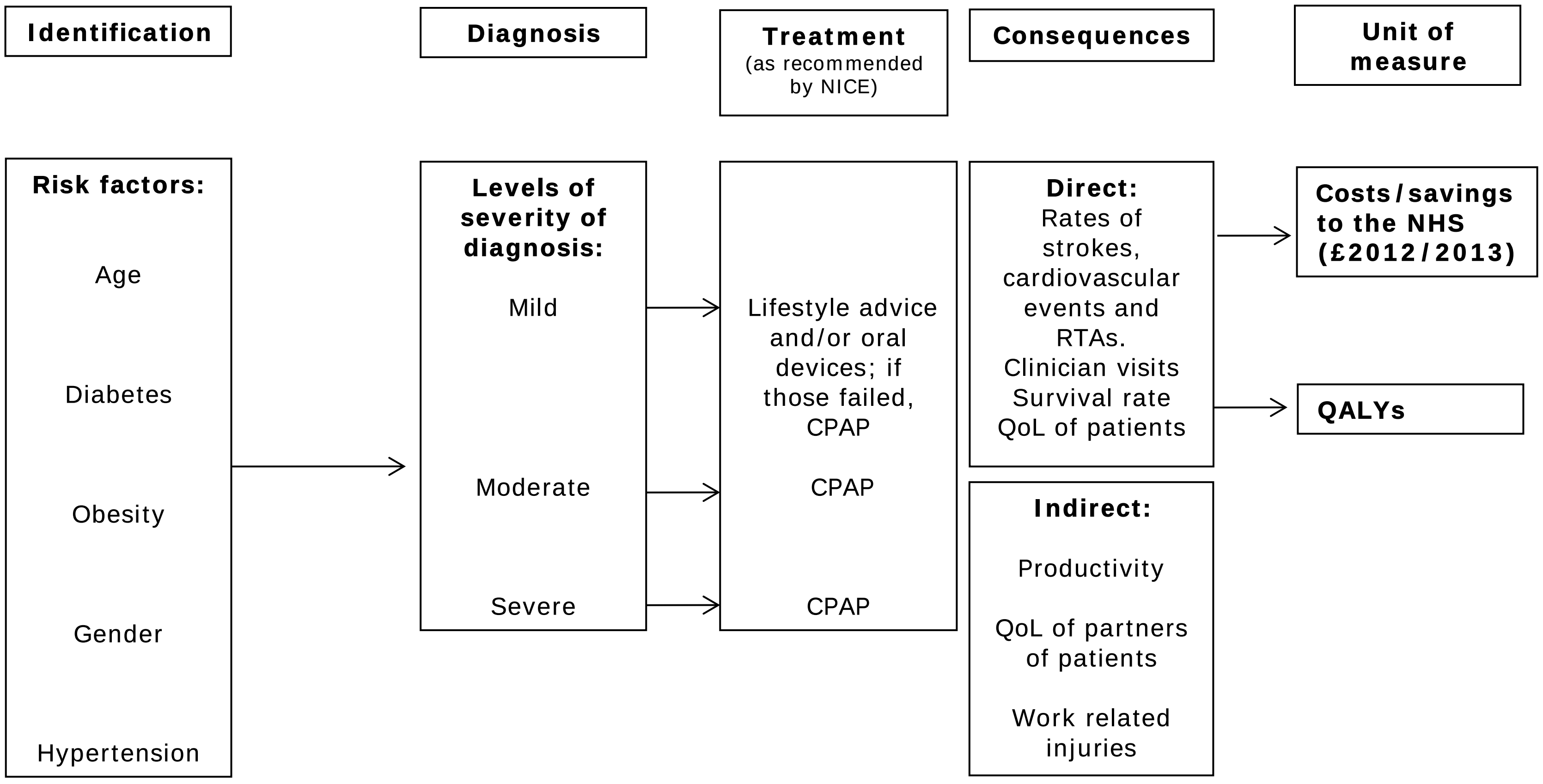
The evidence around the costs and health effects of the first line of treatment recommended for mild cases of OSA (i.e., oral devices and lifestyle advice) is scarce and we deemed it to be insufficient to be included in our estimates in the next chapter of this report.

5. CONSEQUENCES OF OSA AND IMPACT OF TREATING OSA

In this chapter we discuss estimates provided in the literature on the incremental benefits and costs of treating OSA patients as compared to not treating them. Some of these estimates are then used to assess the total burden of OSA in the UK and potential benefits to patients, the NHS and society if OSA patients are treated.

Figure 2 depicts the logical structure we used to estimate the incremental costs/savings and benefits of treating versus not treating OSA. Our estimates are based on existing published literature. In the previous two sections we focused on the first three steps of the patient healthcare pathway (identification, diagnosis and treatment). In this section we present the consequences of OSA when not diagnosed and/or not treated, and then the potential impact of treating OSA.

Figure 2. Incremental cost savings and health benefits: Treated vs untreated OSA



Note: QoL = Quality of life.

Co-morbidities are conditions and events that occur with OSA more frequently than in the general population. Risk factors are different as they are conditions or characteristics that make a person more likely to have OSA. Although the quality of the studies proving the association and causation between OSA and other conditions is varied, we report below the key findings on co-morbidities, and whether they are applicable to a UK setting (given that some evidence is not UK-specific).

The literature provides evidence showing association between OSA and stroke and cardiovascular events (Marin et al., 2005; Mar et al., 2003). Guest et al. (2008) used some of the results of those studies to populate their cost-effectiveness model to estimate the risk of cardiovascular events and stroke. More details are provided in Table 1.

An Australian study provided the estimates of hypertension (2.1%), diabetes (2.9%), depression (8.3%), motor vehicle accidents (7.6%), and workplace injuries (9.1%) attributable to sleep disorders (Hillman et al., 2006). However, given this study was not specific to OSA, and it was mainly relevant to the Australian context we did not consider its results for our estimates (presented in Chapter 5).

The literature also reported that the increased risk of conditions like diabetic retinopathy in OSA patients (West et al., 2010) could affect the rate of traffic accidents due to reduced sight. However, given the absence of a specific estimate of the effect of CPAP on this condition we have not included this element in our calculations.

Direct costs– treating vs not treating OSA

Table 1 reports an estimate of direct costs from an NHS perspective, which include costs of diagnostic sleep studies, of managing the condition and treating it with CPAP (i.e., clinician visits, CPAP devices but also management of co-morbidities and other consequences of OSA).

Our estimates were mainly based on a study considered in the NICE TA 139: Guest et al. (2008). We did not select the model developed by the University of York (NICE, 2007) as a source of evidence, because it did not provide sufficient details on the cost data which did not allow us to calculate yearly per patient costs. The NICE Appraisal Committee for TA 139 reviewed both the economic model provided by the University of York (NICE, 2007) and by one of the manufacturers (ResMed – later published in a peer reviewed journal as Guest et al. (2008)) and noted that the base-case ICERs in both analyses were below £5,000 per QALY gained (see Appendix for further details on the key differences between the models).

The characteristics of the patient population on which the baseline costs and QALYs in this analysis were based were: a 55 year-old patient with severe OSA as defined by an AHI >30 and daytime sleepiness (Epworth Sleepiness Scale score ≥12). This patient population is similar to the patient population described in the NICE costing template (NICE, 2008b) in terms of age, as the average age at first diagnosis is 57, but it is narrower in terms of the population, as it focuses on severe rather than moderate to severe. The cost of diagnostic sleep studies constituted only 1% of the total costs (Guest et al.,2008).

Guest et al. (2008) estimated a discounted cost over 14 years of £10,645 (95% confidence interval (CI) £7,988 to £14,098) for untreated patients and £9,672 (95% CI £8,057 to £12,860) for patients treated with CPAP (Guest et al., 2008). Thus treatment with CPAP saves £973 per patient over 14 years. Treating OSA decreases the relative risk of having stroke (by 49%), a cardiovascular event (by 46%) and the risk of RTAs (by 31%) (Guest et al., 2008). This reduces the cost of managing those events (within the health sector) while the cost of CPAP remains constant. At the end of the 14 year period considered, treating patients with CPAP is cost-saving compared to not treating them (£973 saving per person). It is worth highlighting that these costs are discounted applying a 3.5% yearly rate to reflect people's time preference (i.e., people tend to value more current costs and benefits than those occurring in the future) as recommended by NICE.

This is consistent with previous empirical evidence in a retrospective observational cohort study in the US where it was reported that treating people with OSA with CPAP reversed the trend of increasing health care utilisation seen prior to diagnosis (Albarrak et al., 2005).

Table 1. Direct costs for treated versus untreated patients

<table>
<tr><th colspan="4">Direct costs</th></tr>
<tr><th></th><th>If untreated</th><th>If treated</th><th>Reference</th></tr>
<tr><td rowspan="2">Total health care cost per person (clinician visits for OSA; devices; diagnostic sleep studies; management of cardiovascular events; strokes; and road traffic accidents)</td><td>£ 10,645 (UK £ 2005/06)</td><td>£ 9,672 (UK £ 2005/06)</td><td rowspan="2">Guest et al. (2008) - UK</td></tr>
<tr><td colspan="2">The use of CPAP over 14 years is expected to result in a cost reduction of £973 (95% CI -£1,983 to £1,508) due to:
• decrease the relative risk of cardiovascular event by 46%;
• decrease the relative risk of stroke by 49%;
• decrease the relative risk of RTAs by 31%;
• increase the probability of survival by 25%.</td></tr>
</table>

The country, the currency and the reference year are in brackets next to the cost. In later chapters of the report we convert all financials to £Sterling in 2012/13 price terms.

Other evidence on direct costs

Road traffic accidents

Due to day time sleepiness, OSA is associated with a greater risk of having a road traffic accidents (RTA) (NICE,2008b; Douglas et al., 2002), which can be lethal and non-lethal.

The costing template that accompanied NICE TA 139 (NICE, 2008b) stated that increased use of CPAP by 59,400 patients could lead to approximately 7,000 fewer road traffic accidents each year, which implies one fewer road accident per year for every 8.5 people treated for OSA. Using the estimate of the number of adults currently untreated in the UK (i.e., 337,863 – see Table 6), if this ratio of prevented accidents per person treated per year was applied, we would see approximately 40,000 fewer road accidents per year in the UK. The majority of accidents do not result in fatality or injury. Nevertheless the benefit of this many fewer accidents would be considerable. This is in line with the conclusions of a study from Canada that examined motor vehicle collisions (MVC) data for people with OSA before and after starting treatment with CPAP, and for an equal number of matched controls. The study concluded that the increased risk of MVC in people with OSA is removed when patients are treated with CPAP (George, 2001).

Consumption of medication to treat co-morbidities

A Canadian study (Mehta et al., 2012) found that 38% of patients treated with CPAP reported a reduced consumption of concomitant medicines for management of diabetes, cardiovascular disease, asthma and gastro-oesophageal reflux disease compared to when they were not treated. However, the paper does not provide an estimate of the size of such reduction. Therefore, we could not consider this in our estimate of total cost/saving of treating OSA. In addition, it is possible that part of this reduction in medication is already taken into account in the Guest et al. (2008) estimate of the reduced cost of managing stroke and cardiovascular events, although only partially as the paper focused on management of acute events rather than that of long term conditions.

Consumption of NHS resources

There are differences between the consumption of health care resources of people with OSA diagnosed and undiagnosed that are worth highlighting. International evidence provides estimates suggesting that the health care consumption of people with undiagnosed (and therefore untreated) OSA is approximately twice the resource use of matched controls (Kapur, 1999; Ronald et al., 1999; Tarasiuk et al., 2005; Jennum and Kjellberg, 2011). In particular, Ronald et al. (1999) found that physician visits were approximately doubled in cost for the patients group compared to controls, and hospital stays accounted for 1,118 nights (6.2 per patient) in hospital versus 676 nights (3.7 per patient) for controls over the ten-year period. Therefore, it seems reasonable to conclude that the consumption of health care resources, with physician visits and hospital stays amongst them, tends to be approximately half for OSA patients being treated relative to those undiagnosed and untreated.

Direct health benefits– treating vs not treating

Table 2 sets out the direct health benefits of treating people with CPAP; and they are substantial. It shows that treating with OSA could increase survival rates by 25%. This means that treating all 667,000 adults estimated to have moderate to severe OSA in the UK would lead to around 100,000 more people surviving at 14 years than if none of them were treated.

Table 2 also shows the positive impacts of using CPAP on the health-related quality of life of patients (although not as substantial as the impact of the survival rates). This difference might partly be due to the characteristics of the EQ-5D measures of health-related quality of life. In particular, none of its five dimensions (i.e., mobility, self-care, usual activities, pain/discomfort and anxiety/depression) refers specifically to sleepiness.

Overall, Guest et al. (2008) report a total QALY gained (composite measure of quality and length of life) of CPAP versus no treatment of 0.87 (difference between 8.09 QALYs if treated and 7.22 QALYs if untreated in Table 2).

Table 2. Direct benefits for treated patients versus untreated patients

Direct benefits			
	If untreated	**If treated**	**Reference**
Health related quality of life (HRQoL) measured using EQ-5D (i)	EQ-5D: 0.79	EQ-5D: 0.84	Jenkinson et al. (1997) - UK
	EQ-5D: 0.73	EQ-5D: 0.77	Chakrovarty et al. (2002) - UK
	EQ-5D: 0.74	EQ-5D: 0.81	Mar et al. (2003) – Spain
Survival at 14 years	57%	72%	Guest et al. (2008) – UK
QALYs (ii)	QALYs: 7.22 (6.48 to 7.93)	QALYs: 8.09 (7.17 to 8.44)	

(i) EQ-5D is a generic (not disease specific) instrument to measure health related quality of life on a scale from 0 to 1 (representing full health)
(ii) QALY = Quality-adjusted life year gained. QALYs combine quality and length of life components. Based on the Markov model, differences in health gain between patients receiving and not receiving CPAP becomes apparent after two to three years of treatment. The QALYs shown in the table above were gained after 14 years of treatment (95% confidence intervals shown in parentheses)

Consequences of OSA - indirect costs

In addition to direct NHS costs and patients' health loss, having OSA can also have indirect effects on people close to the patients (e.g. quality of life for the partners of patients) and on patients' ability to work, which has negative effects on the national economy.

Table 3 shows an estimate of the economic burden of OSA in Europe including productivity losses due to absence from work and early retirement of OSA patients (Gibson et al., 2013).

Table 3 also provides an estimate of the value that society puts on the number of lives forgone by not treating everyone estimated to have OSA in the UK. We assumed that people with OSA have a life expectancy 20 years shorter than the average life span in the general population, as estimated by Young and Finn (1998), and that treating OSA significantly increases survival of OSA patients (see Table 2). A monetary value of a life saved is not a reflection of costs that fall on the NHS, but reflects the average value that society gives to a statistical life (i.e. not that of any identified individual). Therefore, the monetary value of a life saved is not included in the analysis of direct costs or benefits to the NHS that we described in the previous chapter and that we present in the next chapter, but it should be kept in mind as part of the wider value to UK society of treating

OSA. The value to society of preventing a fatality, based on willingness to pay measures (WTP) in the UK in 2009, was estimated at £1.6 million, a figure used by the UK Government when economically evaluating investments in transport safety (Department of Transport, 2011). Other, smaller, numbers are used in the same way to put a value on avoiding non-fatal injury to people as a result of accidents.

It has also been shown that, because of sleepiness, OSA patients of working age can have a reduced ability to work. A large register-based study of public sector employees in Finland (not shown in Table 3) suggests that the development of sleep apnoea substantially increases the number of lost workdays (Sjösten et al., 2009), which has a negative impact on the economy. In an Australian study by Hillman et al. (2006) (not shown in Table 3), the estimated cost of work-related injuries attributable to sleep disorders was of Aus$1.96 billion (net of health costs).

Table 3. Indirect costs of OSA in Europe

Indirect costs		Reference
Value of lives forgone (in 14 years) by not treating OSA	Around 100,000 more people could live for more than 14 years if everyone with moderate to severe OSA was treated with CPAP. The value to society of preventing a fatality is £ 1.6 million in the UK.	Guest et al., 2008 Department of Transport, 2011 – UK
Total indirect cost of OSA in Europe	€ 1.9 billion*	Gibson et al. (2013) - Europe

*Aggregated annual indirect costs and the value of disability-adjusted life-years (DALYs) lost for EU countries 2011 (€ billion at 2011 values). Calculated combing the number of DALYs lost due to OSA with the value of a statistical life (€55 000) (Gibson et al. (2013)

Indirect benefits – treating vs not treating

Table 4 shows that treating OSA patients of working age with CPAP can have positive indirect effects, including increasing productivity at work (see first two rows of the table) and reducing the probability of a work-related injury.

Work related injuries cost the UK in the year 2010/11 a total of £5.4 billion (Health and Safety Executive, 2013). A study based on Australian data (Hillman et al., 2006), estimated that 9.1% of work-related injuries were attributable to OSA. Assuming the same percentage was applicable to the UK, and that treating OSA with CPAP would remove the risk of work-related injuries (just as it does with motor vehicle collisions as per George (2001)), we can estimate that treating OSA with CPAP would reduce the cost of work-related injuries to the UK society by £491 million.

The improved quality of sleep that treating OSA with CPAP brings to the patient also benefits their bed partners. Improvements in the partners' quality of life have been measured using different indexes as shown in Table 4. All the figures presented imply an improvement in the quality of life of bed partners of patients treated with CPAP as compared to non-treated.

Table 4. Indirect benefits for treated patients versus untreated patients (partners of patients are included in the second half of the table – indirect costs and benefits)

Indirect benefits			
	If untreated	**If treated**	**Reference**
Subjective job productivity (on a 10-point scale)	6.8	8.4	ResMedica Clinical Newsletter (2009) – US
Productivity (measured with the Endicott Work Productivity Scale (EWPS) (i))	26.6±10.7	18.3 ±8.5 ($p<0.001$)	Nena et al. (2013) - Greece – this study is still in progress
Work related injuries	Total cost of work related injuries to the UK (2010/2011): £5.4 billion Proportion attributable to OSA: 9.1%	Savings if work related injuries attributable to OSA were prevented = £491 million	Health and Safety Executive (2013) - UK Hillman et al. (2006) - Australia
HRQoL of partners of patients	ESS(ii) = 7.4 ± 6.1 SAQLI(iii) = 4.5 ± 1.3 SF-36 (SD): role-physical=50.5 (40.8), vitality= 36.2 (25.5), social functioning= 71.7 (24.4), and mental health= 73.0 (16.0)	ESS(ii) = 5.8 ± 4.7 ($p < 0.001$) SAQLI(iii) = 5.1 ± 0.9 SF-36 (SD, p value): role-physical=72.7 (37.7, $p<0.001$), vitality = 61.2 (22.4, $p<0.001$), social functioning=85.6 (SD 23.9, $p=0.001$), and mental health=80.5 (SD 19.2, $p=0.004$)	Parish and Lyng (2003) - US

(i) Endicott Work Productivity Scale = Questionnaire designed to measure work productivity on a scale of 100 (worst) to 0 (best).

(ii) ESS = Epworth Sleepiness Scale. The ESS ranges from 0 – 24: 0-10 Normal range; 10-12 Borderline; 12-24 Abnormal.
(iii) SAQLI = sleep apnoea quality of life index. Increases in this index suggest improvement in quality of life.

Assessing the total direct costs and benefits of treating vs not treating OSA in the UK

Our scenarios

In this chapter we combine the estimates of OSA prevalence in the UK outlined in Chapter 3 with the estimates of direct net savings and benefits of treating OSA patients due to reduced probability of stroke, cardiovascular event and RTAs (discussed in the preceding chapters) to calculate the net costs and benefits of treating OSA in the UK with CPAP. It is worth noting that we have not included the indirect benefits of treating OSA, including productivity, as those are not captured within the NHS and so would not be considered by local commissioners when making implementation decisions. However, we can highlight that the estimate presented in Table 6 would be larger if all positive health and economic effects (direct and indirect) are taken into account.

Table 5 presents the three scenarios used for our calculations.

Table 5. Description of the scenarios

No treatment scenario	Current scenario	Increased uptake scenario
Nobody with OSA in the UK receives treatment	This represents the “status quo” where a large portion of OSA patients are not diagnosed and treated in the UK (only 330,000 are treated out of a total prevalent population of 1.5 million)	Everyone with moderate to severe OSA (45% of the total OSA population) in the UK is assumed to be diagnosed and treated

There are a number of assumptions underlying our estimates:

- Assumption 1 - Costs and benefits are equally distributed over the lifetime of OSA patients. Therefore we took an average of the total costs and benefits per year (expressed in QALYs) over a 14 period indicated in Guest et al. (2008). We know that there is a skewed distribution of costs that increase significantly towards the end of life, and also that the average person would have better health in earlier years of life than in older age. However, assuming this for both costs and benefits and for both treated and untreated groups balances out the possible bias this might introduce into the calculations given that it would not affect the difference between both groups. We also note that costs might be higher in the first years of implementation due to the device acquisition cost that will incur at the beginning.
- Assumption 2 - The only treatment offered to individuals with OSA is CPAP. In addition, we assumed that the target in the “increased uptake scenario” is to provide treatment to individuals with moderate to severe OSA, assuming that people with mild OSA would not receive CPAP at all. Given the lack of evidence around the use of oral appliances and lifestyle advice in mild OSA as discussed,

and the likely lower benefits of CPAP to them, we have assumed the proportion of people with mild OSA who would be treated with CPAP to be negligible. As per NICE guidance, they would likely be offered alternative treatments as a first line. This also allows us to produce a more conservative estimate of the potential benefit that an increase in the diagnosis and treatment of OSA people can generate.

- Assumption 3 - As a consequence of the previous assumption, we applied the QALYs gained estimated for patients with severe OSA to the patients with moderate OSA. This should not be an issue as NICE showed that there was only a slight difference in the cost effectiveness of the moderate versus the severe subgroup of patients with the latter having a lower cost per QALY ratio (NICE, 2008a).
- Assumption 4 - Compliance issues are taken into account in Guest et al. (2008) estimates of direct costs and QALY gains (74% compliance in the first year, with a 3.8% decrease in compliance in the second year and subsequent yearly decreasing attrition rates). We know that some patients are offered oral appliances when they present compliance issues with CPAP. This has consequences in the cost and benefit profile of that patient. However, given the limited evidence on the most appropriate strategy for this group of patients, we have not included a disaggregated sum of costs and benefits for patients that do not comply with their CPAP treatment and are offered alternative treatments.

Estimates of the total direct costs and benefits of treating vs not treating OSA in the UK

In Tables 6 and 7 we have expressed all financial values in 2012/13 price terms (for example this has the effect of increasing by 19% the cost and saving figures that were expressed in 2005/06 prices in Table 1).

The costs per patient per year include all costs and savings accruing to the NHS for OSA including costs of diagnosis, of the devices, of managing stroke, cardiovascular events and RTAs.

The health gains measured with the QALY capture the survival gains (25%) due to the use of CPAP.

Table 6. Estimates of costs (in 2012/2013 price terms) and benefits of treating people with OSA in the UK

	No treatment scenario	Current estimated scenario	Increased uptake scenario	Reference
Total UK population	63,182,178			Census UK, 2011
Total adult UK population (≥16)	51,307,392			Census UK, 2011
Number of adults with OSA in the UK	1,483,303			Adaptation of Moore, 2012
Number of adults with moderate to severe OSA in the UK	667,486			Adaptation of Moore, 2012
Number of adults with moderate to severe OSA treated	0	329,623	667,486	Adaptation of Moore, 2012
Number of adults with moderate to severe OSA untreated	667,486	337,863	0	Adaptation of Moore, 2012
Rate of identification and treatment	0.00%	22.22%	45.00%	OHE estimates
Cost per patient per year (£2012/13)	If untreated = £905.21 If treated = £822.48			Adaptation of Guest et al., 2008
Health benefits per patient per year	If untreated = 0.52 QALYs If treated = 0.58 QALYs			Adaptation of Guest et al., 2008
Total annual NHS costs (£2012/13)	**£604 million**	**£577 million**	**£549 million**	OHE estimates
Total annual QALYs	**347,000**	**367,000**	**387,000**	OHE estimates

To show more clearly the differences in costs and benefits of treating different proportions of OSA patients, Table 7 contains the incremental cost savings and QALYs gained of moving from the “no treatment” scenario (where no OSA patients in the UK are treated) to the “current” scenario and the “increased uptake” scenario (where some and all patients with moderate to severe OSA are treated respectively). For example, we estimate that treating the whole moderate to severe OSA patient population would result in savings to the NHS totalling approximately £55 million and around 40,000 QALYs gained by patients, compared to no patients having been diagnosed and treated.

Table 7. Health benefits and cost savings of treating OSA with CPAP in the UK – cost savings and health benefits of treating OSA

	No treatment scenario	Current estimated scenario	Increased uptake scenario
Total annual NHS cost savings from treatment (£2012/13) (versus no treatment)		**£27 million**	**£55 million**
Total additional QALYs gained per annum from treatment (versus no treatment)		**20,000**	**40,000**

Summary

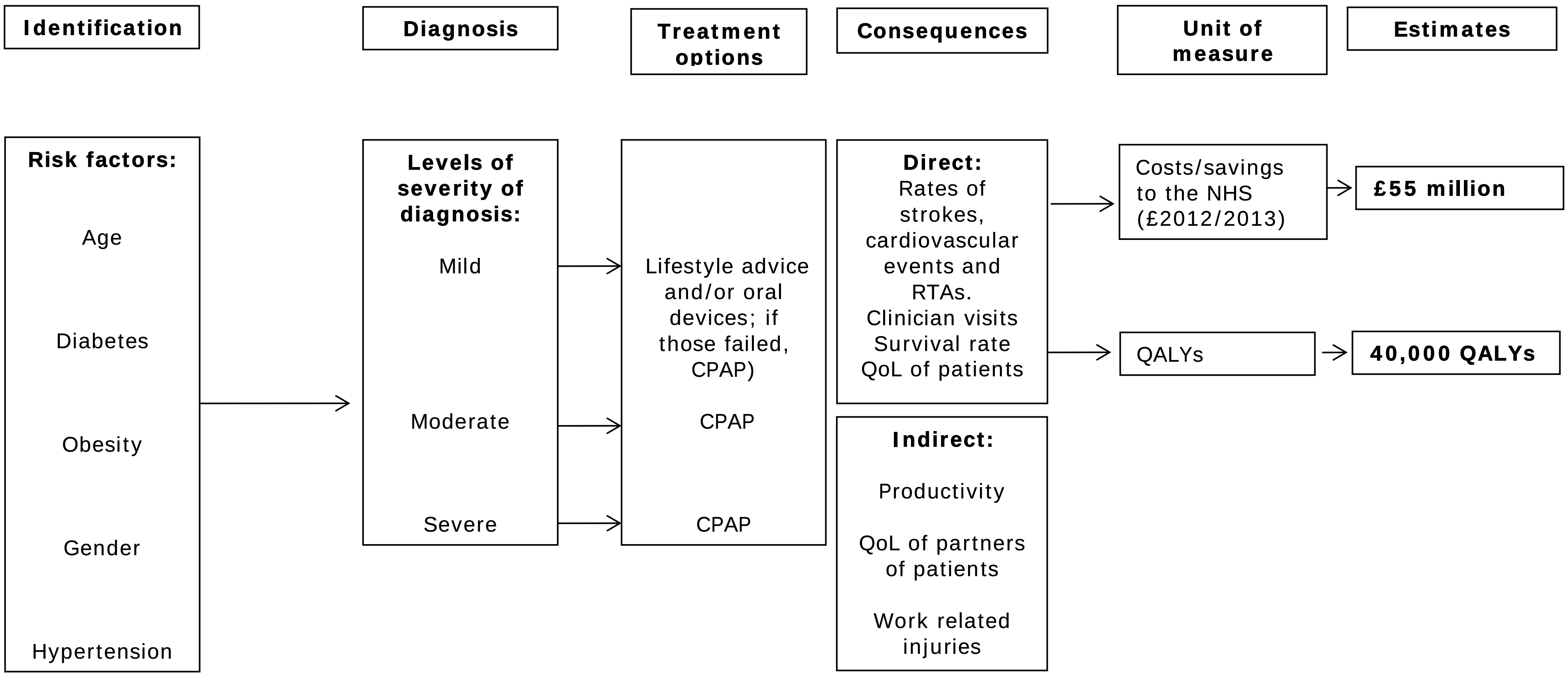
Based on our estimates, the total direct costs attributable to the management of moderate to severe OSA for the NHS are higher if people are not treated than if people are treated for this condition.

Comparing the current scenario, where only 330,000 adults across the UK are treated for OSA, with a scenario in which all individuals in the UK with moderate to severe OSA are diagnosed and treated (increased uptake scenario), the NHS could **save a further £28 million annually** and **generate an extra 20,000 QALYs per year**.

We are taking a conservative approach as we assume nobody with mild OSA will use CPAP neglecting all potential benefits that CPAP could potentially bring to this subgroup of the population. We are also ignoring possible further savings from a reduced use of medicines for co-morbidities such as cardiovascular disease, asthma and gastro-oesophageal reflux disease, as suggested (but not quantified) by Mehta et al., 2012. Finally, we have not included potential indirect benefits beyond the NHS, such as productivity gains and quality gains to people close to the patients. Figure 3 captures all effects of treating vs not treating, direct and indirect, financial and non-financial, but includes only an estimate of the total direct savings and health gains of treating OSA in the UK.

Nevertheless, the results of our conservative approach for the calculations should be an encouragement for commissioners of care in the UK to pursue the identification and treatment of people with OSA in their catchment areas.

Figure 3. Incremental cost savings and health benefits: Treated vs untreated OSA



Note: QoL = Quality of life.

Source OHE Consulting calculations

6. DIRECT COSTS AND BENEFITS OF OSA ACROSS THE UK

Two recent UK wide studies have highlighted a high level of variation in the rate of referral to sleep studies across regions in the UK (Denton et al., 2014) and a mismatch within areas between the estimated risk of OSA and availability of sleep centres (Steier et al., 2014). This undermines horizontal equity in the delivery of health care, which requires that patients with equal need receive equal treatment (Wagstaff et al., 1989).

OSA experts at a conference organised by the British Lung Foundation identified some specific features of OSA care in the four UK countries (British Lung Foundation, 2014):

- In England, mechanisms for paying for sleep services are not considered fit for purpose in the field of OSA.
- Key challenges for access to care in Northern Ireland are: a big increase in demand; funding resources are based on old estimates of prevalence; a backlog of people to be treated with CPAP.
- In Scotland, there is significant variation in the provision of services for OSA. The key challenges are: exponential rise in new patient referral numbers for suspected OSA; geographical inequity of access to OSA services; limited technical diagnostic support in tertiary referral centres; and lack of standardisation of clinical practice.
- The Welsh Sleep Group has reported a continued shortfall in estimated referral to treatment times in 2010 and 2012, in referral to diagnosis times and in recommended staffing ratios.

In Figure 3 above we showed that not treating OSA appropriately is also inefficient given the cost savings to the NHS that can be generated by treating all individuals with moderate to severe OSA. In the chapters below we present the total direct cost savings and benefits that can be generated if OSA was treated in each UK country.

We do not have access to country-specific prevalence data so we applied our calculations presented in Table 6 to sizes of the populations of the four UK countries (indicated in Table 9). This might cause some degree of over – or under- estimated numbers in some regions. For instance, looking at Figure 1 we see that Wales has a predominantly high risk of OSA while Northern Ireland has a low estimated risk of OSA. Therefore, we can predict that for Northern Ireland the numbers presented here are likely to be slightly overestimated while for Wales they might be underestimating the real picture. England and Scotland present a more mixed picture with some regions having lower and others higher estimated risk of OSA.

Tables 10-13 show the costs and health benefits (estimated in QALYs) resulting from each our three scenarios (see Table 5, which we have repeated below as Table 8 for ease) in each of the four UK countries, based on the assumption that prevalence of OSA is distributed across them in proportion to their total adult populations.

Table 8. Description of the scenarios

No treatment scenario	Current scenario	Increased uptake scenario
Nobody with OSA in the UK receives treatment	This represents the "status quo" where a large portion of OSA patients are not diagnosed and treated in the UK (only 330,000 are treated out of a total prevalent population of 1.5 million)	Everyone with moderate to severe OSA in the UK is assumed to be diagnosed and treated

Table 9. Demographic data from the four UK countries

	England	Northern Ireland	Scotland	Wales	Reference
Population	53,012,456	1,810,863	5,295,403	3,063,456	Census UK, 2011
Adult population (≥16)	42,989,620	1,431,540	4,379,072	2,507,160	
Prevalence estimate of moderate to severe OSA in adults	559,276	18,624	56,970	32,617	Adapted from Moore, 2012
Number of adults with moderate to severe OSA estimated to be treated	276,186	9,197	28,133	16,107	OHE calculations

Given that the evidence suggests long term health benefits and cost savings from treating OSA with CPAP, the bigger the gap between prevalence and provision of treatment the higher the size of potential benefits and cost savings from expanding the provision of treatment to everyone estimated to have moderate to severe OSA (i.e., the increased uptake scenario).

In the following sub-sections, we will present the costs and health benefits (expressed in QALYs) for each of the three scenarios. First, we present the total annual cost to the NHS of not treating OSA. Then, we outline the cost to the health service in each of the four countries of the UK of the current estimated scenario where approximately 330,000 people are estimated to be receiving treatment in the UK. Additionally, we show the savings and the health benefits (in QALYs) that currently treating moderate to severe OSA generates compared to not treating OSA, and for a scenario where everyone estimated to have moderate to severe OSA was treated.

England

England is the biggest and most populated of the four countries in the UK, with approximately 84% of the adult of population in the UK. Therefore, it is expected that, in absolute terms and if no major differences in prevalence of OSA or in provision of services exist, England accounts for the largest size of savings and health effects that could be generated by treating moderate to severe OSA.

According to our estimates shown in Table 10, treating OSA can yield around 33,600 QALYs yearly in England. If everyone estimated to have moderate to severe OSA was treated, the NHS in England would be saving approximately £46.3 million compared to a scenario where none of them were treated.

Table 10. Direct costs and health benefits of people with moderate to severe OSA in England

	No treatment scenario	Current estimated scenario	Increased uptake scenario
Total annual NHS costs (£2012/13)	£506.3 million	£483 million	£460 million
Total annual NHS cost savings from treatment (£2012/13) (versus no treatment)		£22.8 million	£46.3 million
Total additional QALYs gained p.a. from treatment (versus no treatment)		16,571	33,557

Source: OHE Consulting calculations.

Northern Ireland

Table 11 shows that if no OSA patients estimated to be currently treated received treatment in Northern Ireland, the cost to the Irish NHS would be around £16.9 million.

Our estimates suggest that if all individuals with moderate to severe OSA were treated (increased uptake scenario), the cost savings to the Northern Ireland NHS would be around £1.5 million, and the health benefit to the patients would be approximately 1,117 extra QALYs compared to a scenario where none of them were treated.

Table 11. Direct costs and health benefits of people with moderate to severe OSA in Northern Ireland

	No treatment scenario	Current estimated scenario	Increased uptake scenario
Total annual NHS costs (£2012/13)	£16.9 million	£16.1 million	£15.3 million
Total annual NHS cost savings from treatment (£2012/13) (versus no treatment)		£0.8million	£1.5 million
Total additional QALYs gained p.a. from treatment (versus no treatment)		552	1,117

Source: OHE Consulting calculations.

Scotland

Table 12 shows that if no OSA patients estimated to be currently treated received treatment in Scotland the cost to the Scottish NHS would be around £51.6 million.

Our estimates suggest that if all individuals with moderate to severe OSA were treated (increased uptake scenario), the cost savings to the Scottish NHS would be around £4.7 million, and the health benefit to the patients would be approximately 3,418 extra QALYs compared to a scenario where none of them were treated.

Table 12. Direct costs and health benefits of people with moderate to severe OSA in Scotland

	No treatment scenario	Current estimated scenario	Increased uptake scenario
Total annual NHS costs (£2012/13)	£51.6 million	£49.2 million	£46.9 million
Total annual NHS cost savings from treatment (£2012/13) (versus no treatment)		£2.3 million	£4.7 million
Total additional QALYs gained p.a. from treatment (versus no treatment)		1,688	3,418

Source: OHE Consulting calculations.

Wales

Table 13 shows that if no OSA patients estimated to be currently treated received treatment in Wales, the cost to the Welsh NHS would be around £29.5 million.

Our estimates suggest that if all individuals with moderate to severe OSA were treated (increased uptake scenario), the cost savings to the Welsh NHS would be around £2.7 million, and the health benefit to the patients would be approximately 1,957 extra QALYs compared to a scenario where none of them were treated.

Table 13. Direct costs and health benefits of people with moderate to severe OSA in Wales

	No treatment scenario	**Current estimated scenario**	**Increased uptake scenario**
Total annual NHS costs (£2012/13)	£29.5 million	£28.2 million	£26.8 million
Total annual NHS cost savings from treatment (£2012/13) (versus no treatment)		£1.3 million	£2.7 million
Total additional QALYs gained p.a. from treatment (versus no treatment)		966	1,957

Source: OHE Consulting calculations.

Our estimates suggest that in each the four UK nations, extending the current provision of services to treat all individuals with OSA would have positive health effects for them and would generate cost savings to their respective NHS.

7. COST OF IMPLEMENTATION TO THE NHS AND VALUE FOR MONEY COMPARED TO OTHER INTERVENTIONS

The cost of implementing the recommendations derived from NICE TA 139 for the adult population of England is estimated by NICE to be around £70.2 million in the first year, with an annual recurrent cost of £20.4 million after that (NICE, 2008b). We have provided evidence (based largely on Guest et al., 2008) that suggests that treating OSA is ultimately cost saving from the perspective of the NHS in the long run owing to reductions in consequential illnesses, and that it has important societal benefits, such as improved productivity and a positive impact on the quality of life of partners of OSA patients.

To get some sense of relative scale, NICE's estimates of the short run costs of treating OSA with CPAP can be compared with the £4.69 billion that the NHS in England spent on all forms of respiratory treatments in 2012/13. Table 14 sets this out alongside the costs of some other categories of treatment, taken from the latest NHS England Programme Budget expenditure data (NHS England, 2014).

Table 14. NHS England Programme Budget expenditures 2012/2013: expenditures in selected disease areas

(Sub) Programme Budgeting Category	**Expenditure (in £billion)**
Mental Health Disorders	11.28
Problems of Circulation	6.90
Cancers & Tumours	5.68
Problems of the Musculoskeletal System	5.34
Problems of the Genito-Urinary System	4.78
Problems of the Gastro Intestinal System	4.76
Problems of the Respiratory System. Within Respiratory:	4.69
Obstructive Airways Disease (COPD)	0.80
Asthma	1.05
Other **(including OSA)**	2.85
Neurological	4.44
Endocrine, Nutritional and Metabolic Problems	3.06
Total spending reported in all areas	94.78

Source: NHS England, 2014.

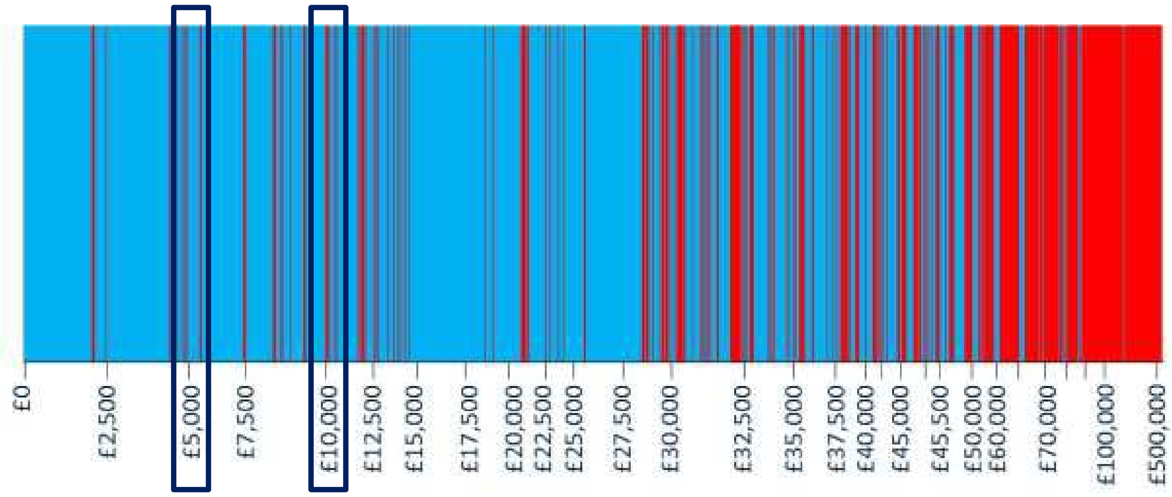
Table 14 shows a selection of eight of the twenty three Programme budgeting categories that the NHS classifies its spending in. The sub-category 'Other' within the budgeting category of "problems of the respiratory system" contains spending in OSA. The budgeting category of respiratory problems received approximately 5% of the NHS England expenditures, and the sub-category within which OSA is included accounts for approximately 3% of NHS England's budget.

In Scotland, using data from 2007/08, the total amount invested in problems of the respiratory system was £508 million, which was 6.3% of total health care expenditure, a higher percentage than in England (the sub-category 'other' was not reported within respiratory problems) (The Scottish Government, 2012). In Wales, the total spent in respiratory problems in the 2011/12 budget was £355 million, which was 6.6% of the total expenditure. Equivalent programme budget expenditure data are not available for Northern Ireland.

NICE has noted that the incremental cost-effectiveness ratio (ICER) of CPAP for moderate and severe OSAHS was below £10,000 per QALY gained and therefore agreed that, for people with moderate or severe OSAHS, CPAP would be an appropriate use of NHS resources and should be recommended as a treatment option (NICE, 2008a). Dakin and colleagues have studied the frequency of recommendations or rejections amongst published NICE TAs with ICERs in them. Figure 4 shows the 510 NICE decisions they analysed: red lines represent a rejection and blue lines represent recommendations (Dakin et al., 2013). We have highlighted the £5,000 and the £10,000 per QALY gained figures mentioned in the NICE TA 139 for severe and moderate OSA respectively, saying that the ICER values for CPAP for these patients groups were below these marks. It is clear that there is a high number of TAs with positive recommendations that were given to technologies with higher cost per QALY gained than CPAP (i.e. the number of blue lines to the right of our two estimates is very high in the figure). Therefore, we can say that CPAP offers greater value for money to the NHS than many other technologies that have been recommended by NICE.

If, on the basis of Guest et al. (2008), treating OSA with CPAP eventually saves the NHS cost, then CPAP becomes “dominant”, as it both reduces costs and increases patients’ health.

Figure 4. Impact of ICER ranking on recommendations



Notes: Decisions are ranked by ICER, with NICE decisions to ‘recommend’ shown in blue and to ‘reject’ shown in red. For clarity, only the first five datasets of randomly-sampled ICERs are shown.

Source: Dakin et al., 2013.

8. CONCLUSIONS

In the UK, the presence of OSA is not evenly distributed across regions and the provision of sleep services does not follow a similar pattern to the estimated presence of the disease. This could not only create undesirable inequities in the system, but it could also pose a barrier to the appropriate identification of cases in all regions of the UK.

The identification of people with OSA is a necessary first step to treating patients in line with NICE guidance. For the treatment of OSA, NICE has determined CPAP to be effective and an efficient use of NHS resources. Guest et al. (2008), show that such treatment is eventually cost saving to the NHS. Some uncertainty remains around the optimal treatment strategy for people with mild OSA. Nevertheless, it is clear that not treating them is the least desirable scenario. The evidence we have presented suggests that there is a need to fix an inequitable distribution of services that does not adequately respond to the need of patients. Investing in the identification and treatment of OSA in the UK would mitigate long term costs that people with untreated OSA impose on the NHS budget mainly due to increased rates of strokes, cardiovascular events and accidents.

Our estimates of cost savings and health gains derived from treating everyone estimated to have OSA in the UK are as follows:

- Annual savings to the NHS in the UK would total £55 million and 40,000 QALYs, if all people with moderate to severe OSA were to be diagnosed and treated, relative to none being diagnosed and treated.
- Relative to the estimated level of treatment of 330,000 adults with OSA across the UK, achieving 100% diagnosis and treatment of people with moderate to severe OSA could yield extra annual savings of £28 million and 20,000 extra QALYs.
- Those estimates of cost savings from the NHS perspective are due to reductions in consequential acute events (including stroke, cardiovascular events and RTAs) resulting from treatment with CPAP.
- Treating OSA with CPAP offers greater value for money to the NHS than many other technologies recommended by NICE.
- According to NICE, the annual number of road traffic accidents could be reduced by one for every 8.5 patients treated with CPAP (NICE, 2008b). If everyone estimated to have moderate to severe OSA in the UK were treated, this could result in 40,000 fewer road accidents each year relative to the current level of treatment. As some of these accidents result in injury or even fatality, the health gains are considerable.
- Treating OSA with CPAP will also lead to benefits from a broader societal perspective, beyond the direct costs to the UK NHS and the health benefits to OSA patients. The evidence suggests that treating OSA with CPAP improves patients' productivity at work and could reduce the cost of work-related injuries to the UK society by £491 million. Treating OSA also improves the quality of life of the bed partners of people with OSA.

To summarise, treating everyone with moderate to severe OSA in the UK could double the amount of cost savings to the NHS and also the health benefits to patients.

Considering all the above, and the current high estimates of unidentified and untreated people with OSA in the UK, there seem to be considerable potential health and economic gains that better diagnosis and treatment of OSA could achieve. This applies to the UK as whole and to each individual UK countries (England, Northern Ireland, Scotland and Wales).

The current provision of services seems insufficient to cover the needs of people with OSA in the UK. Identification of people with OSA needs to be followed by timely cost-effective treatment. Those are the conditions that an equitable and efficient NHS would need to fulfil to meet the needs of people with OSA and avoid unfair inequities and inefficiencies in the system.

9. FURTHER RESEARCH

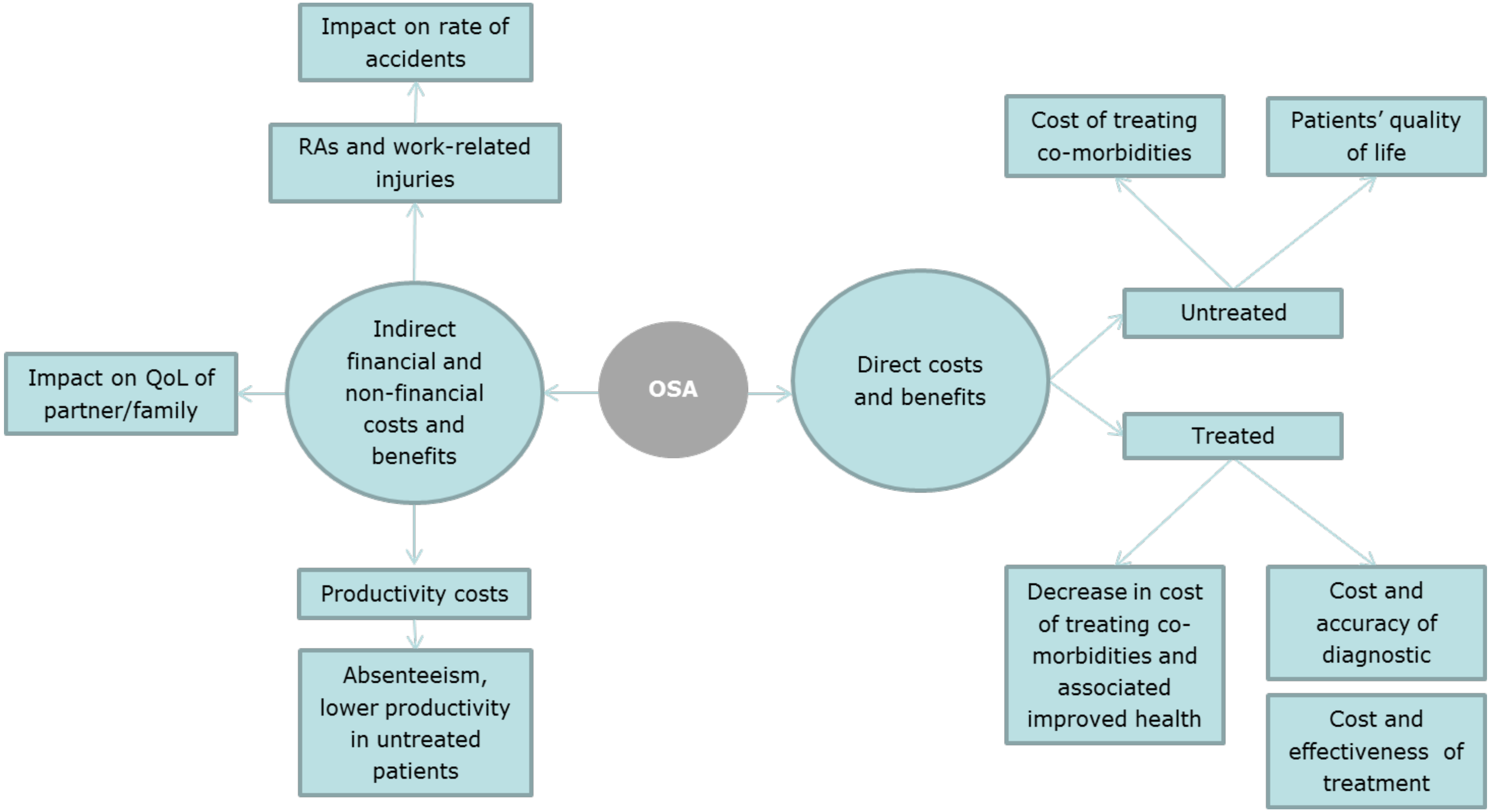
The evidence we presented points towards the potential of achieving considerable health and economic gains if the population of adults with OSA in the UK were to be diagnosed and treated according to existing NICE guidance.

Nevertheless, we also identified areas that merit further research in order to improve clinical practice and the management of OSA:

- OSA can be diagnosed via a variety of different approaches but more robust cost-effectiveness evidence on those approaches needs to be collected.
- Cost effectiveness evidence around the optimal intervention for mild OSA remains uncertain.
- Oral devices have a role to play in the treatment of OSA. However, despite existing evidence highlighting the role for oral devices in people with mild OSA and in people not suitable for treatment with CPAP, there remains uncertainty around the cost effectiveness of these interventions in other patient populations
- There is evidence around the effect of treating OSA on the rates of acute events (cardiovascular, Stroke and RTAs). However, more evidence is needed around the causality between OSA and certain conditions such as diabetes and hypertension, and the effects that CPAP has on the consumption of medications to treat such co-morbidities.
- There is no clear evidence assessing the current use of CPAP across the UK and possibly for identifying any “postcode prescribing”. Collecting this evidence would form the basis to further analysis identifying barriers for the uptake of NICE guidance.

APPENDIX

The economics of OSA: direct and indirect costs and benefits associated with treating vs not treating OSA



Note: QoL = Quality of life; RAs = Road accidents.

Key differences between the Assessment Group model of NICE TA 139 and the Guest et al. (2008) model

In TA 139, the NICE Appraisal Committee reviewed both the economic model provided by the Assessment Group (NICE, 2007) and by one of the manufacturers (ResMed). The latter was published in a peer reviewed journal (Guest et al.,2008).

The base-case ICERs in both analyses were below £5,000 per QALY gained. However, in the model by Guest et al. (2008) after 13 years of treatment CPAP becomes dominant compared to no treatment, whereas in the Assessment Group model the cost-effectiveness of CPAP compared to conservative management is of £3,899 per QALY gained.

The implications of these results are similar (i.e., the technology is a cost-effective use of NHS resources), but we deemed highlighting some key differences between both models appropriate to understand what might drive the different results:

- The comparators are not the same. The Assessment Group model compares CPAP to either use of dental devices or of conservative management. Guest et al. (2008) compare CPAP to no treatment.
- The evidence used for estimating the impact of treatment is not the same in both models. Guest et al. (2008) used the incidence of cardiovascular and cerebrovascular events reported by Marin et al. (2005) in their uncontrolled observational study, while the Assessment Group model used Framingham risk equations to link risk factors such as blood pressure reported in randomised clinical trials and the incidence of fatal and non-fatal cardiovascular events.
- The time horizon of both models was different. The Assessment Group model used a lifetime horizon and Guest et al. (2008) used a time horizon of 14 years for their model.
- Severity was addressed using subgroup analysis in the Assessment Group model, whereas the Guest et al. (2008) model focused only on the severe population. In the Assessment Group model, even excluding cardiovascular events and RTAs, the cost per QALY of CPAP for moderate and severe OSA was below £10,000 per QALY gained.

Despite these differences, the results of both models suggest that treating people with moderate to severe OSA is a cost-effective use of NHS resources.

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