

DIRECT AND INDIRECT COSTS OF SDB

OSA: Global recommendations

Globally, health departments at all levels of government have a finite amount of money to spend so getting 'value for money' is of key importance. A 'costing' is one criterion used by government bodies to determine their approach to particular treatments.

In the UK, a technology is considered cost-effective by the National Health Service (NHS) if it has a cost-utility of <£20,000 per QALY (Quality Adjusted Life Year). Considering both the clinical and cost effectiveness of CPAP, the UK National Institute for Health and Clinical Excellence – an “independent organisation responsible for providing national guidance on the promotion of good health and the prevention and treatment of ill health”¹ – conducted a study into the use of CPAP for the treatment of OSA.² They recommended CPAP as a treatment for “adults with moderate or severe symptomatic obstructive sleep apnoea/hypopnoea syndrome (OSAHS)” and for adults with mild OSAHS if their symptoms affect their quality of life and ability to conduct their day-to-day business, where other advice or treatments – such as lifestyle advice – have been unsuccessful.

Finland has developed national guidelines for the prevention and treatment of sleep apnoea.³ This ten-year program aims for:

- primary prevention, through lifestyle measures (maintenance of normal weight, abstinence from smoking and reduction in alcohol use) as well as medical intervention to ensure nasal and respiratory tract function
- secondary prevention, through early detection and treatment
- tertiary prevention, preventing the aggravations of sleep apnoea, such as the onset of concomitant illnesses.

They have taken this step because, “If the programme is implemented and the quality of the prevention and treatment of sleep apnoea is improved, sleep apnoea can be treated with the best possible cost-effect ratio. If the programme is not implemented, the costs caused by sleep apnoea, which has proved to be a national health problem in Finland, will increase significantly.”³

The **American Academy of Sleep Medicine** has issued a position statement⁴ on the cost justification for diagnosis and treatment of OSA. The statement sums up the evidence regarding the association of untreated SDB with increased risks of morbidity and mortality, the higher healthcare costs of patients with untreated OSA prior to diagnosis, and the cost-effectiveness of using sleep-monitoring procedures in diagnosing SDB. It concludes that diagnosis and treatment of SDB “are justifiable on the basis of short-term and lifetime cost savings” and “more efficiently accomplished by physician evaluation and sleep monitoring rather than physician evaluation alone.”

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From the Editor



Recent studies into the economics of sleep-disordered breathing show that treatment of obstructive sleep apnea (OSA) by continuous positive airway pressure (CPAP) is not only an effective treatment, but cost-effective as well.

This edition of ResMedica examines the direct and indirect costs of sleep-disordered breathing (SDB) on the community. We have interviewed three authors of key studies into the economics of SDB: Dr Ral Antic from Australia, Professor Julian Guest from the UK, and Dr Najib Ayas from Canada.

Evaluating the costs of a treatment begs the question: why assess a treatment economically? Professor Guest's response to this question sums it up well: “There have to be some criteria against which governments decide to allocate limited resources and money is one such criterion.” Similarly, Tan et al⁵ comment that economic evaluation “can play a useful role in assisting decision-makers, managers and research funding agencies to set priorities ... [and] help focus research agendas on areas where research can yield the greatest net benefits to society.”

To support our three interviews we have included the abstracts of five key publications on this topic.

On a different, but no less interesting, tack we have also included a snapshot of women's relationship with OSA. The interplay of many factors has led to OSA being under-diagnosed in women. In recent years studies have shown that women and men have different presenting symptoms and different patterns of onset. Our case study shows how symptoms can be hidden, even from someone who is vividly aware of the signs and treatment of OSA.

We would like to offer our thanks and appreciation to all of the people who generously gave us their time and expertise to participate in this edition of ResMedica.

Sleep well.

Alison Hansford, Global Editor

The financial and health costs of sleep disorders: a summary

A landmark study in Australia in 2004 evaluated the overall cost of sleep disorders. For Australia (population in 2004: 20.1 million) the direct and indirect costs totalled \$7.494 billion (US).¹

This consisted of:

- \$146 million (US) for direct health costs for sleep disorders
- \$313 million (US) for associated conditions
- \$1.956 billion (US) for work related injuries associated with sleep disorders
- \$808 million (US) for private motor vehicle accidents²
- \$1.201 billion (US) for other productivity losses
- \$100 million (US) for the real costs associated with raising alternative taxation revenue
- \$2.970 billion (US) for the net cost of suffering.

In the 24 months before diagnosis, patients with sleep apnea consumed 1.7 times more healthcare resources than controls matched for age, gender, area of residency and family physician (annual cost of \$948 (US) compared to \$571 (US)).⁴

DIRECT COSTS

Direct health costs include:

- Inpatient hospital costs
- GP costs
- Specialist
- Other health practitioners
- Pharmaceuticals
- Pathology diagnostic imaging
- Outpatient
- Aged care
- Dental
- Research
- Unallocated costs.

Untreated patients with sleep apnea consume a disproportionate amount of healthcare resources:

- Mean direct medical costs of patients with and without obstructive sleep apnea (OSA) during the year prior to diagnosis were significantly greater for patients with OSA (\$2,720 (US)) than those of matched controls (\$1,384 (US)).³
- Severity of sleep apnea was associated with increasing healthcare utilization.³
- In the 24 months before diagnosis, patients with sleep apnea consumed 1.7 times more healthcare resources than controls matched for age, gender, area of residency and family physician (annual cost of \$948 (US) compared to \$571 (US)).⁴

Healthcare expenditure decreases after treatment.⁵

DIRECT EFFECTS

Sleep-disordered breathing, particularly obstructive sleep apnea/hypopnea syndrome (OSAHS), can have significant effects on a person's health and wellbeing. The UK National Institute for Health and Clinical Excellence (NICE) describes OSAHS⁶ as having symptoms of "impaired alertness, cognitive impairment, excessive daytime sleepiness, snoring, nocturia, morning headaches and sexual dysfunction." It adds that "the sleep quality of partners may also be affected. Excessive daytime sleepiness can adversely affect cognitive function, mood and quality of life."

OSAHS is associated with a number of serious health conditions including:

- Obesity⁷
- Hypertension⁸
- Congestive heart failure⁸
- Coronary heart disease and myocardial infarction⁸
- Atrial fibrillation⁸
- Stroke⁸
- Diabetes⁹
- Depression.¹⁰

INDIRECT COSTS

Indirect costs of sleep disorders include:

- Work related injuries:
 - Production disturbance
 - Human capital
 - Legal
 - Investigation
 - Travel
 - Funerals
 - Transfer
 - Caregivers
 - Aids and modifications
- Motor vehicle accidents
- Other productivity costs
- Alternate tax revenue
- Net cost of suffering.¹

INDIRECT EFFECTS OF OSA

Work limitation

- Compared to non-snoring subjects, patients with OSA are significantly more likely to complain of difficulty doing their job because of tiredness/sleepiness.¹¹
- Patients with OSA are significantly more likely to complain of large difficulties in concentrating on new tasks, learning new tasks, and performing monotonous tasks.¹¹
- Patients with an Epworth Sleepiness Scale (ESS) score ≤ 5 have much less work limitation than those with an ESS score ≥ 18 in terms of time management, mental-interpersonal relations and work output.¹²

Occupational injuries

- In the United States in 2005 there were 5,702 work-related fatal injuries, with four deaths per 100,000 workers, per year.¹³
- Sleepiness due to OSA adversely affects vigilance and performance.¹⁴
- Deficits in neurocognitive performance lead to errors while driving and result in increased risks of motor vehicle crashes, including a high rate of collisions in patients who drive as part of their occupation.¹⁵
- A 10 year retrospective study compared occupational accidents between patients suffering from sleep-disordered breathing and age-matched random samples drawn from the general population. It noted a 1.8-fold increase in occupational accidents among male snorers and a 50% increase among men suffering from obstructive sleep apnea syndrome.¹⁶
- A 10 year population-based study noted that men who

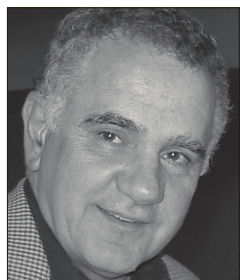
reported both snoring and excessive daytime sleepiness at baseline were at increased risk of occupational accidents, with an adjusted ratio OR of 2.2 (95% CI = 1.3-3.8).¹⁷

Motor vehicle accidents

- Patients with sleep apnea have a 3-to-7- fold increased risk of motor vehicle accidents, with a disproportionate number of these accidents associated with personal injury.^{2,18}
- Of the motor vehicle crashes in the US in 2000, 810,000 collisions and 1400 fatalities were attributable to sleep apnea, with a total cost of \$15.9 billion.¹⁹

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The direct and indirect costs of OSA: An interview with **Dr Ral Antic**



Dr Ral Antic is the Director of the Department of Thoracic Medicine at the Royal Adelaide Hospital (RAH), South Australia. He is also Head of both the Sleep Program and the COPD Program at the RAH and Clinical Senior Lecturer at the University of Adelaide. He is State Director of the South Australian TB Service and

Senior Visiting Respiratory Specialist for five regional hospitals. Dr Antic was the Chairman of the National Asthma Campaign 1989–2005 and has been President of the Australian Tuberculosis and Chest Association since 1999 and Chairman of the Scientific Committee, Asia-Pacific Region, International Union Against TB & Lung Disease since 2006. His other executive positions have included President, Asthma Foundation SA, 1999–2005, Chairman of the National TB Advisory Committee, 1999–2006, Chairman of the Medical and Scientific Committee, Asthma Australia, 2000–2005 and Chairman, Steering Committee Sleep Health Australia, 2003–2006.

Dr Ral Antic was an author¹ and part of the team that contributed to the findings of the Access Economics report,² Wake up Australia: The Value of Healthy Sleep.

The report found that the *direct* costs for sleep disorders comprise only 2% of the overall cost of sleep disorders in Australia. Were you surprised by this finding?

Yes, I was surprised by the relative differences of the direct and indirect costs. However, the model used for that report was a well-established model that *Access Economics* has used for other reports and it does put an emphasis on the indirect areas. We find in many areas of health that direct costs are modest – asthma is similar. I think that direct costs can be underestimated because immediate, face-to-face care is measurable but the non face-to-face time tends to be less visible. This is the time spent on care planning prior to a consultation, looking at data afterwards and so on. This time can be equal to the face-to-face time.

What did the report show about the wider effect of sleep disorders throughout the community?

It showed that sleep disorders and their impact are underestimated, under-diagnosed and under-managed. There is opportunity to change the community's health by improving its recognition and management of sleep disorders. We need to be talking, as a community, about prevention at primary, secondary and tertiary levels. Our potential for having an impact on sleep disorders is far from being fully utilised. The first step is to realise that obstructive sleep apnoea (OSA) is not a disease, but a risk factor – the disease occurs as an end-organ consequence.


What sort of reactions did the health sector, general community and government have to the findings of the report?

At the time of the report's publication in 2005, we had significant short-term interest from the national media, the health sector and the general community. Since then it has often been quoted by researchers and service providers when seeking local and research funds, so in this way it has been a help for the sleep community. We subsequently published an article in *Sleep*, and an editorial in the same issue discussed the value of our research in its own right and as a stepping-stone to build on for further research.³

From your experience, do you think government health departments are aware of the disparity between the direct and indirect costs of sleep disorders?

In South Australia there has been a gradual growth in understanding of the impact of sleep disorders. Government

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departments are aware of the disparity between direct and indirect costs but don't always act on them. Generally, the interest isn't around the indirect costs because they are not immediate enough to create attention. We have identified sleep disorders as a significant risk to the health of our indigenous communities but have a long way to go to affect the health and social impacts this is having, directly and indirectly.

Are there any 'road blocks' to accessing funding for direct costs?

I believe that the main 'road block' is lack of general awareness in the community, government and the health sectors that OSA is a risk factor for so many of our major diseases. The rest is resolvable. People are not recognising the importance of sleep, and are not willing to do something about the potential for harm that OSA presents. Governments are driven by crisis, and if a community is loud enough about a particular issue governments will follow. On the whole, policy can most effectively be changed by the community.

We should position the treatment of OSA as a primary and secondary prevention of disease initiative, which should mean that OSA may attract different funding options, as well as our current approach as treatment for disease management.

How best can the sleep fraternity educate government bodies to improve funding for the direct costs (given that untreated sleep disorders prove to be so much more costly)?

We are working towards developing a community-based organization that can address the issue at all levels. This organization needs to operate at a national level so that it can provide information for the policy-makers, and out into the community. Such an organization would empower the community to seek funding for education, and would avoid the marginalisation of individuals. Operating at a national level it could bring OSA treatment into view alongside other important treatments and emphasise its cost-effectiveness. For instance, if you compare the direct costs and benefits of treating OSA and lipid-lowering initiatives, OSA treatment is significantly more cost-effective.

Should the sleep fraternity / government bodies be spending more time and money on measures to prevent the development of OSA (e.g. promoting a healthy lifestyle, healthy eating, exercise, weight loss, reduction in alcohol intake, good sleep hygiene)?

All these measures should be encouraged. I think we need to be clear about the different roles that we have as individuals in achieving a healthy lifestyle as it relates to OSA. The sleep fraternity doesn't own the problem – its role is to be a technical adviser. The Government's role is to advise and resource the community, and it all has to start with the community demanding action. If we look at smoking rates we can see that they didn't start to decrease until the community said, 'this is an issue for us'.

The sleep fraternity needs to work with the rest of the health

sector to lobby for measures that address all of these lifestyle issues. We need to be working with each other, exchanging agendas and literature. Local, state and national governments should build up the 'lifestyle infrastructure' to cover sleep and other lifestyle issues. The overall cost would be small. Medical school training needs to include the importance of good sleep in its curriculum, both for undergraduate and post-graduate courses. The information stream should begin in primary schools. They are now talking about obesity: that discussion could emphasise the combined importance of exercise, sleep and nutrition.

The *Access Economics* report found that the indirect costs for sleep disorders comprise a substantial portion of the overall cost of sleep disorders in Australia. From your experience how best can the sleep fraternity educate government, health bodies and the general public to help minimise the indirect costs (e.g. the association between OSA and impact on work performance, motor vehicle accidents (MVAs) and other lifestyle factors)?

Again, we need a well-constructed approach at the national level. We need to take the control of this information out of the hands of the media and put it into a central body that is effectively advised. If we look at how asthma has been managed over the last two decades we see that a national body was created to deliver a small number of key messages over a three-year period. Asthma is now a national government health priority. The push was originally from the asthma fraternity and the pharmaceutical industry – now the

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government funds projects, with funding for the infrastructure still coming from industry and the community.

Have the 2003 *Fitness to Drive* guidelines impacted on the incidence of MVAs?

They have improved awareness of the importance of sleep quality in driving safety but not the incidence. There has sometimes been an adverse impact on the rapport between doctor and patient. In states such as South Australia where the onus is on the doctor to notify the authorities if a patient does not meet the guidelines, they have sometimes created a very uncomfortable relationship. Doctors are advisers, not controllers, and the onus should be on the patient to report.

THE DIRECT AND INDIRECT COSTS OF OSA: AN INTERVIEW WITH DR RAL ANTIC CONTINUED >

Sleep disorders, and in particular OSA, have been associated with a number of serious health conditions including obesity;⁴ hypertension; congestive heart failure; coronary heart disease and myocardial infarction; atrial fibrillation; stroke;⁵ diabetes⁶ and depression.⁷

From your experience how well informed are other health professionals about the evidence regarding the link between OSA and other medical conditions?

Other health professionals are increasingly aware of the link between OSA and other medical conditions, and increasingly taking action through referrals to sleep specialists, but it is still early days. The measures we discussed earlier would also have an impact on getting this message across – having a national organization, and introducing the importance of sleep and other lifestyle issues into curricula from primary school to medical school, including training for general practitioners. Health professionals generally learn about other specialties at conferences and meetings, and we are still largely reliant on industry to provide funding for this purpose.

“Other health professionals are increasingly aware of the link between OSA and other medical conditions, and increasingly taking action through referrals to sleep specialists, but it is still early days.”

Are other areas of health aware of the relatively low cost of diagnosing and treating OSA, compared to the costs of leaving it untreated?

Not enough. This cost-effectiveness is yet to be highlighted sufficiently. Their understanding is still quite limited. A national body could articulate the comparative costs more effectively.

Are perceived costs a rate-limiting factor?

Yes, for some, although in reality most can cope and most states in Australia have a scheme for paying the start-up costs of equipment. The actual costs are modest when compared to those of any chronic disease. We found that the cost of replacement masks sometimes have more of an impact on people than the initial set-up cost of the CPAP machine, probably because masks have to be replaced regularly. The major limiting factor is adherence to treatment, but this is not just a problem for OSA. People are very bad at using any treatment long-term. In diabetes and hypertension, for instance, the uptake of treatment is similar to CPAP.

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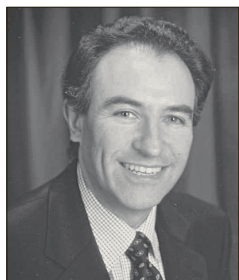
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The cost-effectiveness of CPAP in the UK:

An interview with Professor Julian Guest



Professor Julian Guest has a PhD in molecular neurobiology and a Diploma in Marketing. After obtaining his doctorate from The Institute of Neurology, London University, he continued with genetic research prior to joining the pharmaceutical industry to conduct international

clinical trials. He then moved into marketing and health economics and in 1991, established CATALYST. Under his direction, CATALYST has undertaken numerous international health outcomes research projects in diverse therapeutic areas in Europe, North America, Africa, the Middle East, Far East and Australasia. Professor Guest has published extensively in the field of pharmacoeconomics in relation to these different therapeutic areas and presented at numerous international conferences. In September 2005, he was appointed Visiting Professor of Health Economics at the Postgraduate Medical School, Surrey University, England.

A study¹ by Professor Guest et al estimated the cost-effectiveness of using CPAP in the management of patients suffering from severe OSAHS, compared to no treatment, from the perspective of the UK's National Health Service (NHS). In this study, a Markov model (spanning 14 years) was constructed to assess the cost-effectiveness of CPAP compared to no treatment.

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.
- 30% of untreated patients survive event-free (i.e. no stroke, cardiovascular event or motor vehicle accident) after 14 years compared to 58% of CPAP-treated patients.
- Untreated patients are expected to cost the NHS £10,645 per patient over 14 years compared to £9,672 per CPAP-treated patient.

- Over 14 years, use of CPAP is expected to deliver a cost-reduction of £973 and:
 - 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 a road traffic accident by 31%
 - increase the probability of event-free survival by 92%.
- CPAP treatment for one year was not found to be cost-effective as the QALY (Quality Adjusted Life Year) gained is >£20,000, but after two years of treatment the cost per QALY gained is £10,000 or less, making it cost-effective for the NHS.
- After 13 years CPAP is the dominant treatment (i.e. treatment results in an improved outcome for less cost).

“57% of untreated patients are expected to be alive at the end of 14 years compared to 72% of CPAP-treated patients.”

We spoke to Professor Guest about his study, and the reactions he has had to it.

Can you briefly explain what a Markov model is and why you chose this model to look at the cost-effectiveness of CPAP?

They are advanced decision models that are used to study health states that recur. They are especially useful when analysing treatment response, symptom recurrence and treatment outcomes of a chronic disease, such as severe obstructive sleep apnoea/hypopnoea syndrome (OSAHS) over a specific period of time.

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THE COST-EFFECTIVENESS OF CPAP IN THE UK: AN INTERVIEW WITH PROFESSOR JULIAN GUEST CONTINUED >

What reaction have you had from the NHS in regards to the outcome of your analysis?

The National Institute for Health and Clinical Excellence (NICE) recommended CPAP as a treatment option for adults with moderate or severe symptomatic OSAHS.² CPAP was also recommended as a treatment option for adults with mild OSAHS only if patients' symptoms affect their quality of life and ability to go about their daily activities, and their lifestyle advice and any other relevant treatment options have been unsuccessful or are considered inappropriate. However, these recommendations are based on diagnosis and treatment of OSAHS, with response monitoring being carried out by a specialist service with appropriately trained medical and support staff.

Will this analysis help sleep physicians in the UK acquire extra funding from the NHS to facilitate more timely diagnosis and treatment of patients with OSAHS? If not, what further work or research do you think is required?

It should help, providing they put together a 'good business case' for NHS executives, based on patient numbers, clinical outcomes and costs of (1) diagnosing and treating and (2) not diagnosing and treating.

In your review you refer to studies investigating the cost-effectiveness of CPAP conducted in other countries [see box]. Would this international research have any impact on NHS expenditure towards diagnosing and treating OSAHS?

In my view it won't. Most economic models reflect treatment patterns, resource use reimbursement mechanisms and unit costs in a particular country. However, models can be tailored for other countries by amending treatment patterns and associated resource use (and corresponding costs) to reflect different clinical practices as well as different reimbursement mechanisms.

"Most economic models reflect treatment patterns, resource use reimbursement mechanisms and unit costs in a particular country."

Your model shows that, for users of CPAP, there is a decrease in the relative risk of events such as cardiovascular, stroke and road traffic accidents. Has there been any reaction to these findings from other health specialities and the UK Road and Traffic Authority?

Yes. There has been interest from the Driver and Vehicle Licensing Agency which informs Department of Transport policy.

Your study focused on a model of a patient with severe OSAHS. Given that excessive daytime sleepiness and arousals from sleep can be experienced by OSAHS patients across the spectrum of OSAHS severity and hence can impact on daytime function and general health, would you expect that the cost-effectiveness of CPAP would be similar from mild through to severe OSAHS patients?

Not necessarily. To answer that question a model would have to be built reflecting the management of a mild or moderate sufferer. At the time of performing our study, it was not possible to model the management of mild or moderate OSAHS due to the lack of published clinical data required to inform such modelling.


You mention in the discussion of your study that you only considered direct healthcare costs borne by the NHS and not the indirect costs of other government departments or individuals. What other government departments or individuals would be affected?

Possibly the Department of Transport and Home Office in respect of road traffic accidents and Department of Social Security in respect of rehabilitation services for stroke patients. Patients and their relatives/carers might also be affected in terms of out-of-pocket expenditure and loss of earnings for time missed from work.

Would you expect that if indirect costs were considered, CPAP may be cost-effective earlier than at the two year mark?

One should not combine direct and indirect costs in that way. In our review we assessed clinical outcomes of CPAP and therefore looked solely at the direct cost of resources used in order to achieve the given outcomes. Indirect costs are not directly associated with providing healthcare but are an indirect consequence of illness. So from an NHS perspective our conclusion remains unchanged.

Wittman and Rodenstein³ (2004) mention in their review that 'the dominant philosophy of our society for the time being is essentially materialistic with money as the main endpoint and reference'. When one works at the forefront of



sleep medicine and sees the positive impact that CPAP can have on patients' lives in respect to improving their health, work and social life, is it not a shame that government decisions are ruled so much by expenditure?

There have to be some criteria against which governments decide to allocate limited resources and money is one such criterion. However, it should be noted that in the UK, decisions for allocating healthcare resources are based on cost-utility estimates of different interventions. NICE takes a view that a technology that has a cost-utility of <£20,000 per QALY potentially affords an effective use of NHS resources and should be made available.

“Many of the studies are very conservative and likely to underestimate the impact of CPAP as they did not include benefits in terms of improving work productivity, reducing occupational injuries and improving spousal quality of life.”

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Cost-effectiveness of CPAP therapy

Cost-effectiveness is usually assessed by the incremental cost-effectiveness ratio (ICER). This is the ratio of the change in costs of adopting, or not adopting, a therapy to the change in quality adjusted life years (QALY) that follows. In general an ICER of \$50,000 (US) per QALY is considered to be cost-effective.⁴

AlGhanim et al⁴ cite a number of studies that have shown that the ICER of CPAP is substantially lower than the commonly accepted threshold value of \$50,000 (US) per QALY. They note that many of the studies are very conservative and likely to underestimate the impact of CPAP as they did not include benefits in terms of improving work productivity, reducing occupational injuries and improving spousal quality of life.

The studies include:

A Spanish study⁵ that investigated the impact of CPAP on quality of life, fatalities due to motor vehicle collisions and cardiovascular morbidity/mortality. It gave an ICER of €7,861 per QALY saved.

A US study⁶ that used a Markov economic model to investigate the impact of CPAP on reduction in motor vehicle crash risk, improved quality of life and costs of therapy. The model gave an ICER of \$3,354 (US) per QALY gained from the perspective of the healthcare system and an ICER of \$314 (US) per QALY gained from the societal perspective.

A similar Canadian study⁷ that gave an ICER of \$3,626 (CDN) per QALY gained from the perspective of the healthcare system and an ICER of \$2,979 (CDN) per QALY gained from the societal perspective.

The economic impact of OSA: An interview with **Dr Najib T Ayas**



Dr. Najib Ayas is currently an Associate Professor of Medicine in the Respiratory and Critical Care Divisions at the University of British Columbia and attending staff in the ICU at Providence Healthcare and in the Sleep Disorders Program at UBC Hospital. His research focuses on the public health and safety

consequences of sleep disorders and fatigue. His work has been published in a variety of medical journals including the New England Journal of Medicine, Journal of the American Medical Association, American Journal of Respiratory and Critical Care Medicine, Annals of Internal Medicine and Archives of Internal Medicine.

Your review¹ of the economic impact of obstructive sleep apnea (OSA) yielded a number of interesting observations in relation to work limitations, occupational injuries and motor vehicle crashes (see pages 2–3). Given your experience, did these results come as a surprise to you?

The results as a whole weren't a surprise – you would expect that people who were sleepy would be more subject to lapses in concentration. What did come as a surprise was the magnitude of the impact of OSA, particularly for more severe motor vehicle crashes associated with injury or where pedestrians have been knocked down. There was a five-fold increase in these accidents for people with OSA. The study by Sassani et al² showed that treatment with continuous positive airway pressure (CPAP) would have prevented over half of these crashes and saved about 1000 lives.

One would expect that work limitations would affect both blue and white collar workers. From your experience is one group less likely to seek medical help for an environmental sleep disorder (EDS) or poor work vigilance?

I think that the nature of a blue collar worker's job might lead to OSA being more noticeable. Workers who are operating machines, driving a truck or car, or walking around on scaffolding at a construction site might be more likely to notice reductions in vigilance compared to people sitting at a desk. Also, the more physical nature of blue collar work may make sleepiness more noticeable and more immediate. If a desk-worker is sleepy their work will suffer, but it may not get noticed for some time.


Would you expect that there may be more emphasis on blue collar workers being assessed for sleep apnea given they are more likely to be driving vehicles as part of their work?

Given the data linking sleep apnea to motor vehicle crashes, it seems prudent for truck drivers and other long distance drivers to be screened. Because of the size of trucks, collisions involving trucks are usually more severe than those involving cars, further stressing the potential importance of screening. Probably some sort of objective testing is needed for screening sleep apnea in drivers – subjective questionnaires can be problematic if workers know it might affect their job. Also, I think we need more randomized outcome studies in this area.

You say that “governments, transportation agencies, industry, and insurance companies need to be better informed concerning the economic impact of untreated obstructive sleep apnea (OSA) and the benefits of therapy.”¹ How do you believe one can better inform these bodies and the general public in Canada and the USA in regard to the impact of untreated OSA and the benefits of therapy?

In the last ten years I think people have become more aware of sleep and more interested in its importance. I think we need to get the message out through newspapers and newsletters and through papers that can influence the decision-makers. I think medical schools need to pay more attention to it in their training. Governments and other bodies need to understand that the problem exists but that it can be treated and that the treatment is cost-effective. Australia seems to be doing more than Canada. In Canada we don't see anything like the Australian driver awareness program 'Drive, Revive, Survive' that alerts people to take a break from driving every two hours.

“Governments and other bodies need to understand that the problem exists but that it can be treated, and that the treatment is cost-effective.”



Given that OSA has a big impact on other medical conditions (e.g., cardiovascular disease, diabetes, stroke, depression) from your experience how best do sleep specialists educate other medical specialities in relation to the impact of sleep?

People need to understand the disease and understand that it is treatable. Again, it needs to be introduced at medical school. In Canada and the US it's not a large part of the curriculum.

Your review noted a number of studies^{3,4,5} that showed CPAP has a positive effect on work performance in subjects suffering from OSA [see box]. Do you think employers in general are aware of OSA and the benefits of treating OSA in regard to productivity? If not, how better can they be educated?

I don't think employers on the whole are aware of the problems of OSA or how its treatment can help productivity. It makes logical sense that a sleepy worker will be less productive, but the data on productivity is largely subjective.

Certain professions are becoming more aware. I think the trucking industry is taking this issue more seriously, as are police and firefighters. I was recently shown an article on sleep apnea in a Royal Canadian Mounted Police (RCMP) newsletter. When people are carrying guns, the implications of losing concentration because of sleepiness are magnified.

"I don't think employers on the whole are aware of the problems of OSA or how its treatment can help productivity."

I also think people in sedentary jobs should be concerned about the effect their job is having on their health. Just looking at the connections between OSA and obesity shows that these people should be trying to increase their physical activity. At the other end of the spectrum, elite athletes such as professional football players have to think about their health once they retire from their sport. Many find it hard to adjust their eating habits even though they aren't exercising for eight hours a day.

Your 2006 paper concludes with the statement that, "When quality of life, costs of therapy, and motor vehicle crash outcomes are considered, CPAP therapy for patients with OSAH (obstructive sleep apnea/hypopnea) is an excellent use of health care resources."⁶ Your 2008 review¹ compares the costs of CPAP therapy with the costs of other types of intervention and found that the data for CPAP consistently demonstrated that its cost was substantially lower for the benefit received. What

response have you had to these findings from government or other agencies?

Although we have shown that CPAP is much more cost-effective than many of the interventions we do in healthcare, we haven't had a huge response from the government. CPAP is only funded in a few Canadian provinces and is actually not funded in my province, British Columbia. I believe it's a slow process and the findings take time to trickle down. I think we're making some slow inroads into their thinking.

What are you working on now?

I'm interested in a number of things at the moment. I work in epidemiology and health services, so in terms of OSA I'm looking at the impact of sleep apnea on work-related injuries; the most cost-effective way of diagnosing sleep apnea – whether there are alternatives to polysomnography that give as good results; whether new technology improves CPAP compliance. I'm also very interested in looking at the impact of long or intense work hours of healthcare workers to examine the impacts on patient and occupational safety.

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Effects of CPAP on work performance

After CPAP, patients with OSA (AHI>20) were significantly less likely to report difficulty in performing their job due to tiredness or sleepiness, and were significantly less likely to report difficulty concentrating on new tasks and performing monotonous tasks.⁴

OSA patients treated with CPAP had significant improvements in time management, mental-interpersonal relationships, and work output dimensions of the Work Limitations Questionnaire.³

Subjective job productivity increased from 6.8 to 8.4 (on a 10-point scale) in patients with OSA treated with CPAP.⁵

The invisible woman: gender differences in sleep-disordered breathing

According to research conducted over the last ten years, OSA is being overlooked in women because the symptoms do not conform to those that are expected. While women present with more sleep-related complaints than men,¹ these complaints are often not being recognised as indicators of OSA.

According to some studies as many as four men are diagnosed with obstructive sleep apnea (OSA) to every one woman.² While there are certain physiological features making women slightly less prone to apneas,³ the major difference lies in the presenting symptoms for OSA in men and women. Women's presentation of sleep apnea is less likely to include a 'classic' history of witnessed apneas and heavy snoring, making women's symptoms less likely to lead to a diagnosis. The findings of many of the studies are summed up by Quintana-Gallego et al who concluded that "women with OSA may be underdiagnosed due to circumstances related to the family lifestyle and socio-cultural factors in addition to different OSA clinical expression."⁴

For many men, the first sign of sleep-disordered breathing (SDB) is snoring. However, many women who present with insomnia, or non-specific symptoms such as fatigue or mood disturbance, are later found to have OSA.⁵ Women with SDB at a tertiary level are also reported to complain significantly more often than men of restless legs, depression, nightmares and palpitations at night and hallucinations.⁶ Women have been found to have more fatigue, morning headaches, insomnia and depression and to use sedatives more frequently than men. They were also older, more obese (although with an obesity pattern less centrally distributed) and referred for hypertension more frequently than men.⁷

A further difference between men and women that appears to affect reporting numbers is the greater willingness of women to attempt to self-medicate. More than twice as many women as men were observed to use conventional medications (including prescription and over-the-counter medications) for sleep-related problems.⁸

OSA has serious effects on many aspects of a person's health. Women with OSA are more likely than men to have comorbidities such as obesity, fibromyalgia, migraine, depression, and irritable bowel syndrome.⁹ Women with OSA also have a higher risk of hypothyroidism and arthropathy, but a lower overall risk for cardiovascular disease.¹⁰

Hormonal changes have a marked effect on women's sleep patterns. This is particularly noticeable after puberty, in menstruation, pregnancy and menopause.¹¹ After menopause women have increased prevalence and severity of OSA,¹² making

their levels of OSA comparable to those in men.¹³ This coincides with an increase in the occurrence of cardiovascular death and events.¹⁴ Gislason et al found that OSA is a relatively common occurrence among women, especially postmenopausal ones, and it is strongly related to hypertension."¹⁵

Physiological differences between the sexes play a role in the lower occurrence of OSA in women. Orth et al found that these factors include "craniofacial morphology and function, gender-specific body-fat distribution and hormonal influences on ventilation and dilating muscles in the oropharynx."¹⁶ The collapsible upper airway also differs between men and women, with airway length becoming significantly greater in boys than in girls after puberty.¹⁷

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Sleep apnea – a significant piece of my health puzzle

Sleep apnea was the last piece of my health puzzle to be detected and diagnosed – it should have been one of the first, considering I work in the industry that helps treat this condition.

Two years ago I was living life to the fullest, enjoying my work, contributing passionately, socializing actively, travelling as much as I could ... and taking my health for granted.

Then I began to feel quite run down. My anxiety level went up along with my heart rate. I attributed it to stress and lack of fitness so I took a holiday and stepped up time at the gym.

Things did not improve. I now know why we have different words for varying degrees of feeling weak – tiredness, fatigue, exhaustion ... I would add to that 'drop-dead exhaustion'. In preparation for my consultation with my general physician (GP), I created a 'health map' of my symptoms, personal and family health history. Despite my understanding of sleep apnea, sleep symptoms did not feature at all on this initial health map. There were too many other symptoms to think about.

Tests in May 2007 revealed I had Graves' disease. I responded well to the medication, but many of the symptoms persisted. I had lost a lot of weight before the diagnosis, but put it all on again (and then some!) after treatment started.

In December 2007, new tests revealed excessive levels of the parathyroid hormone. This was not connected to thyroid problems but rather to calcium and Vitamin D levels. I experienced the benefits of Vitamin D supplementation but still had long bouts of feeling unwell. I still did not pay any attention to my sleep and my husband had not noticed anything amiss either (perhaps because he is a snorer!).

Since I have a family history of diabetes, my blood sugar and insulin resistance were also being monitored. My persisting fatigue and other symptoms were now attributed to insulin resistance. Each condition in itself appeared to be manageable but the combination was enough to knock me out.

By July 2008, I began to recognize in myself some cognitive and emotional changes. I discussed my diagnosis and symptoms with a colleague who is a clinical specialist. She promptly queried whether I had been tested for sleep apnea. Not in the last two years, was my answer. I mentioned it to my GP and was tested. A couple of years ago, a similar test had shown some amount of flow limitation but not apnea. This time my AHI (apnea-hypopnea index) was 16 – high enough to require treatment.

Initiating positive airway pressure therapy is usually a bit daunting. It took some learning, and a very good clinician to help me through the initial setup and familiarization. I am fortunate

to be in an environment where I can query the experts directly. The support of a partner, loved ones, friends and colleagues is absolutely priceless.

I have been on positive airway pressure therapy for just over five months now, while continuing my other medication. In a few months' time I will be taken off the Graves' medication to check whether or not it is in remission. While fingers are crossed, in the meanwhile I am relieved that different aspects of my health – awake and asleep – are being treated and I'm on my way to rediscovering myself!

“Since I have a family history of diabetes, my blood sugar and insulin resistance were also being monitored. My persisting fatigue and other symptoms were now attributed to insulin resistance. Each condition in itself appeared to be manageable but the combination was enough to knock me out.”

The economics of sleep-disordered breathing: Key research articles

1. AlGhanim N, Comondore VR, Fleetham J, Marra CA, Ayas NT. The economic impact of obstructive sleep apnea. *Lung* 2008 Jan-Feb;186(1):7-12. Epub 2007 Dec 8.

Untreated obstructive sleep apnea (OSA) increases healthcare utilization and is associated with reduced work performance and occupational injuries. The economic burden related to untreated OSA is substantial, accounting for billions of dollars per year. Furthermore, therapy of OSA is an extremely cost-efficient use of healthcare resources, comparing highly favorably with other commonly funded medical therapies. Governments, transportation agencies, industry, and insurance companies need to be better informed concerning the economic impact of untreated OSA and the benefits of therapy.

2. Hillman DR, Murphy AS, Antic R, Pezzullo L. The economic cost of sleep disorders. *Sleep* 2006 Mar 1;29(3):299-305.


STUDY OBJECTIVES: To determine the economic cost of sleep disorders in Australia and relate these to likely costs in similar economies. **DESIGN AND SETTING:** Analysis of direct and indirect costs for 2004 of sleep disorders and the fractions of other health impacts attributable to sleep disorders, using data derived from national databases (including the Australian Institute of Health and Welfare and the Australian Bureau of Statistics). **MEASUREMENTS:** Direct health costs of sleep disorders (principally, obstructive sleep apnea, insomnia, and periodic limb movement disorder) and of associated conditions; indirect financial costs of associated work-related accidents, motor vehicle accidents, and other productivity losses; and nonfinancial costs of burden of disease. These were expressed in US dollars. **RESULTS:** The overall cost of sleep disorders in Australia in 2004 (population: 20.1 million) was \$7494 million. This comprised direct health costs of \$146 million for sleep disorders and \$313 million for associated conditions, \$1956 million for work-related injuries associated with sleep disorders (net of health costs), \$808 million for private motor vehicle accidents (net of health costs), \$1201 million for other productivity losses, \$100 million for the real costs associated with raising alternative taxation revenue, and \$2970 million for the net cost of suffering. **CONCLUSIONS:** The direct and indirect costs of sleep disorders are high. The total financial cost (independent of the cost of suffering) of \$4524 million represents 0.8% of Australian gross domestic product. The cost of suffering of \$2970 million is 1.4% of the total burden of disease in Australia.

3. Guest JF, Helter MT, Morga A, Stradling JR. Cost-effectiveness of using continuous positive airway pressure in the treatment of severe obstructive sleep apnoea/hypopnoea syndrome in the UK. *Thorax* 2008 Oct;63(10):860-5. Epub 2008 Apr 11.

OBJECTIVE: A study was undertaken to estimate the cost-effectiveness of using continuous positive airway pressure (CPAP) in the management of patients with severe obstructive sleep apnoea/hypopnoea syndrome (OSAHS) compared with 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 with 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 Sleepiness 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 with 72% of patients treated with CPAP. Untreated patients are expected to cost the NHS £10,645 (95% CI £7,988 to £14,098) per patient over 14 years compared with £9,672 (95% CI £8,057 to £12,860) per CPAP-treated patient. Treatment with CPAP for a period of 1 year was found not to be a cost-effective option since the cost per quality-adjusted life year (QALY) gained is expected to be > £20,000, but after 2 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 (ie, more effective than no treatment for less cost). **CONCLUSION:** Within the limitations of the model, CPAP was found to be clinically more effective than no treatment and, from the perspective of the UK's NHS, a cost-effective strategy after a minimum of 2 years of treatment.

4. Ayas NT, FitzGerald JM, Fleetham JA, White DP, Schulzer M, Ryan CF, Ghaeli R, Mercer GW, Cooper P, Tan MC, Marra CA. Cost-effectiveness of continuous positive airway pressure therapy for moderate to severe obstructive sleep apnea/hypopnea. *Arch Intern Med* 2006 May 8;166(9):977-84.

BACKGROUND: Obstructive sleep apnea-hypopnea (OSAH) is a common disorder characterized by recurrent collapse of the upper airway during sleep, and is associated with an increased risk of motor vehicle crashes (MVCs). Common first-line therapy for OSAH is continuous positive airway pressure (CPAP). We assessed the cost-effectiveness of CPAP therapy vs none for the treatment of OSAH. **METHODS:** We used a 5-year Markov model that considers the costs and quality-of-life improvements of CPAP therapy, accounting for the gains from reduced MVC rates. Utility values were obtained from published studies. The MVC rates under the



CPAP and no-CPAP scenarios were calculated from National Highway Traffic Safety Administration data and a systematic review of published studies. Costs of MVCs, equipment, and physicians were obtained from US Medicare and the National Highway Traffic Safety Administration. The target population included male and female patients aged 25 to 54 years and newly diagnosed as having moderate to severe OSAH. We examined the findings from the perspectives of a third-party payer and society. **RESULTS:** From a third-party payer or a societal perspective, CPAP therapy was more effective but more costly than no CPAP, with incremental cost-effectiveness ratios of \$3354 or \$314 per quality-adjusted life-year gained, respectively. The incremental cost-effectiveness ratio estimate was most dependent on viewpoint (varying more than 10-fold between societal and third-party payer perspectives) and choice of utility measurement method (varying more than 5-fold between the use of standard gamble and EuroQol 5D utility assessment values). **CONCLUSION:** When quality of life, costs of therapy, and MVC outcomes are considered, CPAP therapy for patients with OSAH is economically attractive.

5. McDaid C, Griffin S, Weatherly H, Durée K, van der Burgt M, van Hout S, Akers J, Davies RJ, Sculpher M, Westwood M. Continuous positive airway pressure devices for the treatment of obstructive sleep apnoea-hypopnoea syndrome: a systematic review and economic analysis. *Health Technol Assess* 2009 Jan;13(4):iii-iv, xi-xiv, 1-119, 143-274.

OBJECTIVES: To determine the clinical effectiveness, safety and cost-effectiveness of continuous positive airway pressure (CPAP) devices for the treatment of obstructive apnoea-hypopnoea syndrome (OSAHS), compared with the best supportive care, placebo and dental devices. **DATA SOURCES:** The main search was of fifteen electronic databases, including MEDLINE, EMBASE and the Cochrane Library, up to November 2006. **REVIEW METHODS:** Randomised controlled trials (RCTs) comparing CPAP with best supportive/usual care, placebo, and dental devices in adults with a diagnosis of OSAHS were included. The primary outcomes of interest were subjective daytime sleepiness assessed by the Epworth Sleepiness Scale (ESS) and objective sleepiness assessed by the Maintenance of Wakefulness Test (MWT) and the Multiple Sleep Latency Test (MSLT). A new economic model was developed to assess incremental cost per quality-adjusted life-year (QALY). The cost-effectiveness of CPAP was compared with that of the use of dental devices and conservative management. The costs and QALYs were compared over a lifetime time horizon. Effectiveness was based on the RCT evidence on sleepiness symptoms (ESS), which was 'mapped' to utilities using individual patient data from a subset of studies. Utilities were expressed on the basis of generic HRQoL instruments [the EQ-5D (EuroQoL-

5 Dimensions) in the base-case analysis]. The base-case analysis focused on a male aged 50. A series of subgroup and scenario analyses were also undertaken. **RESULTS:** The searches yielded 6325 citations, from which 48 relevant clinical effectiveness studies were identified, 29 of these providing data on daytime sleepiness. The majority of the included RCTs did not report using an adequate method of allocation concealment or use an intention-to-treat analysis. Only the studies using a sham CPAP comparator were double blinded. There was a statistically significant benefit with CPAP compared with control (placebo and conservative treatment/usual care) on the ESS [mean difference (MD) -2.7 points, 95% CI -3.45 to -1.96]. However, there was statistical heterogeneity, which was reduced when trials were subgrouped by severity of disease. There was also a significant benefit with CPAP compared with usual care on the MWT. There was a non-statistically significant difference between CPAP and dental devices (six trials) in the impact on daytime sleepiness (ESS) among a population with moderate symptom severity at baseline (MD -0.9, 95% CI -2.1 to 0.4). A review of five studies evaluating the cost-effectiveness of CPAP was undertaken. All existing cost-effectiveness studies had limitations; therefore a new economic model was developed, based on which it was found that, on average, CPAP was associated with higher costs and benefits than dental devices or conservative management. The incremental cost per QALY gained of CPAP was below £20,000 in the base-case analysis and most alternative scenarios. There was a high probability of CPAP being more cost-effective than dental devices and conservative management for a cost-effectiveness threshold of £20,000 per QALY gained. **CONCLUSIONS:** CPAP is an effective and cost-effective treatment for OSAHS compared with conservative/usual care and placebo in populations with moderate to severe daytime sleepiness, and there may be benefits when the disease is mild. Dental devices may be a treatment option in moderate disease but some uncertainty remains. Further research would be potentially valuable, particularly investigation of the effectiveness of CPAP for populations with mild sleepiness and further trials comparing CPAP with dental devices.

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