Societal costs of obstructive sleep apnoea syndrome

Philippa Gander, Guy Scott, Kara Mihaere, Helen Scott

Abstract

Aim To estimate the societal costs of obstructive sleep apnoea syndrome (OSAS) in New Zealand and develop a simulation tool to evaluate treatment options.

Method Treatment profiles, availability, uptake, and costs were based on services in the Wellington Region, and were used to develop a decision analytic model with micro costing of each potential outcome. Sensitivity analyses were conducted with 10,000 Monte Carlo simulations randomly varying each model parameter between high and low estimates.

Results Total annual societal costs of OSAS for New Zealanders aged 30–60 years were estimated at $40 million (range $33–$90 million) or $419 per case, with accidents being the major contributor. This included 58% direct medical, 13% direct non-medical, 25% indirect, and 3% intangible costs. The estimated incremental net cost of treating OSAS was $389 per case treated (range $338–$427). The estimated incremental net direct medical cost per quality of life year (QALY) gained was $94 (range $56–$310).

Conclusion The estimated incremental direct medical cost per QALY gained by OSAS treatment is well below the average QALY cost ($6865) for drugs selected by PHARMAC to receive government subsidy for use in the healthcare system. Thus, the analysis strongly supports the cost effectiveness of OSAS treatment.

Obstructive sleep apnoea syndrome (OSAS) is a progressive disease that forms part of a spectrum of sleep-related breathing disorders. It is characterised by the occurrence of repetitive episodes of airflow reduction (hypopnoea) or cessation (apnoea) due to upper airway obstruction during sleep, accompanied by excessive daytime sleepiness.[1]

Untreated OSAS is recognised as an independent risk factor for hypertension, cardiovascular disease, stroke, and motor vehicle accidents (due to excessive sleepiness).[2,3] Evidence for OSAS as an independent risk factor for Type 2 diabetes is less clear. However evidence is converging from experimental sleep restriction studies, epidemiological studies, and intervention studies, to support the conclusion that OSAS exerts independent adverse effects on glucose regulation, through multiple mechanisms.[4] Adults with undiagnosed OSAS are high users of health care services.[5]

In New Zealand, there are marked regional variations in funding for diagnosis and treatment of OSAS,[6,7] which most commonly involves a device to maintain continuous positive airway pressure during sleep (a "CPAP machine"). In the age range 30-59 yrs, Māori are more likely than non-Māori to report OSAS symptoms and risk factors and to have OSAS.[8-10] However, ethnicity is not an independent risk factor after controlling for body mass index (BMI) or neck circumference.[8–10] There is also

evidence that Māori seen at sleep clinics have more severe OSAS than non-Māori, suggesting that there may be barriers for Māori in accessing specialist services.[11,12]

The present study was undertaken to estimate the societal costs of OSAS among people aged 30–60 years, and to develop a simulation tool that could be used to evaluate treatment options, and to estimate the economic impact of OSAS on different population groups.

Methods

Study design—This study was undertaken in Wellington in 2005 and is a combination of cost of illness (COI), cost-benefit analysis (CBA), and cost utility analysis (CUA). The approach was based on an outcome tree and decision analytic model developed using three sets of information:

- The possible pathways of people with OSAS who seek treatment through the healthcare system, and of those who do not seek treatment, and the consequences of decisions made at each point in those pathways;
- The increased risk of accidents and comorbidities associated with untreated OSAS; and
- The costs associated with diagnosis and treatment versus not being diagnosed and/or successfully treated.

The prevalence of OSAS in the Wellington region was estimated to be 5.61% (95%CI 2.62–8.60%).[9,10] The economic analysis was based on 1,692,260 people in the New Zealand population aged 30–59 years.[13]

Pathways through the healthcare system—The pathways in the outcome tree were based on services in the Wellington region (Drs Alister Neill and Angela Campbell, personal communication, 2005. unless otherwise referenced). The first point of contact with the healthcare system for a person seeking treatment for OSAS was a general practitioner (GP), who could recommend no further action, conservative therapies, or provide a referral to the respiratory medicine clinic at the Wellington public hospital. The number of patients who sought treatment for OSAS from their GP was unknown, and capped funding for treatment services beyond primary care made it impossible to estimate the proportion of OSAS sufferers who accessed such services. We have assumed that about 20% of people with OSAS sought treatment from their general practitioner,[14] and of these 50% were referred on to the respiratory medicine clinic at Wellington Hospital.

At the respiratory medicine clinic, patients were triaged based on a clinical evaluation that did not include sleep monitoring. This lead to three possible outcomes: no further treatment recommended; referral back to their GP; or referral to the local specialist sleep clinic (WellSleep). At the time of this study, about 70% of patients seen at the respiratory medicine clinic for suspected OSAS were referred on to the sleep clinic for polysomnographic evaluation.

At the sleep clinic, patients underwent a clinical evaluation followed by an overnight polysomnographic sleep evaluation either in the clinic or at home. About 70% of patients evaluated had a diagnosis of OSAS confirmed. Treatment was initiated according to the severity of OSAS, and consistent with other aspects of the patient's health and life circumstances. An estimated 9% of patients seen at the sleep clinic were recommended conservative therapies for OSAS, 1% underwent surgical treatments, and the remaining 60% were treated with CPAP therapy or dental appliances.

The final version of the model (Figure 1) represents a simplification, with some very low probability outcome pathways excluded and others collapsed (for example, home-based and clinic-based polysomnographic monitoring are not considered separately). This was done in the interests of keeping a manageable level of complexity.

To account for uncertainties in the estimates of the proportion of patients following each trajectory, high and low probabilities were calculated as ±25% of the base case rate. For example, the base case estimate of the proportion of people with OSAS who sought GP treatment was 20%, with a low estimate of 15% and a high estimate of 25%.

Figure 1. The decision analytic model
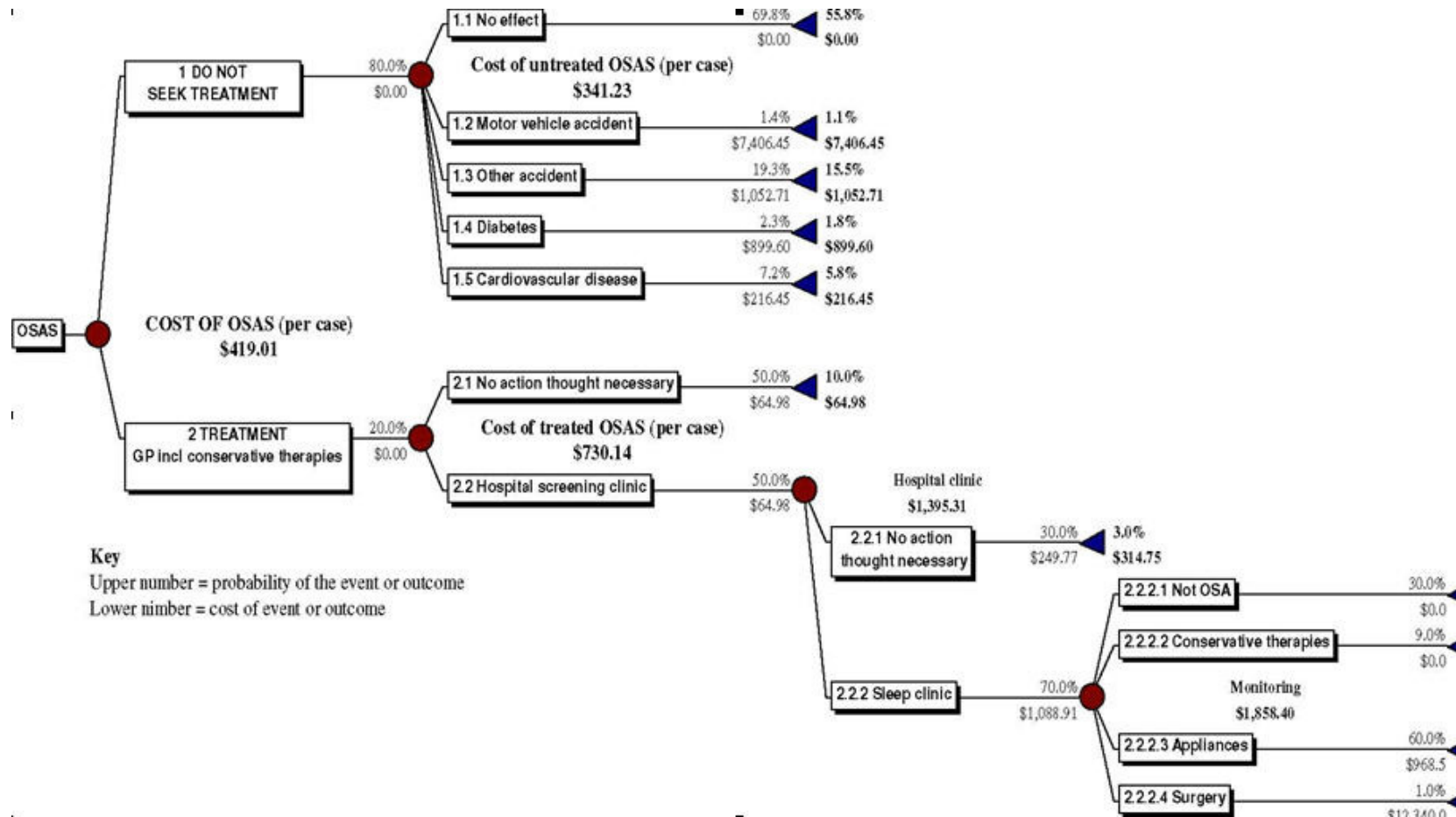
Risk estimates—People with OSAS who did not seek treatment in the mainstream healthcare system were considered to be at increased risk for a number of adverse health and safety outcomes. Attributable fractions for each outcome were based on odds ratios from published meta-analyses of case-control studies, or from longitudinal studies. To account for uncertainties, base case and low and high estimates were calculated for each attributable fraction (Table 1).

Table 1: Attributable fractions for health and safety outcomes associated with untreated OSAS; base case (low estimate-high estimate)

Variables	MVAs	Other accidents	Diabetes	Cardiovascular Disease
OR for untreated OSAS	2.52 (1.83–3.45)[a]	2.2 (1.3–3.8)[b]	1.62 (0.67–3.65)[c]	2.0 (1.42–2.90)[d]
Risk without OSAS	0.09% (0.07–1.0%)	36.1% (27.7–43.8%)	4.0% (2.9–8.5%)	8.6% (6.8–10.8%)
Risk with OSAS	2.3% (1.3–3.5%)	55.4% (33.3–74.8%)	6.3% (2.0–25.4%)	15.8% (9.4–26.0%)
OSAS-attributable fraction	1.37% (0.6–2.45%)	19.31% (5.55–30.95%)	2.31% (0.00–16.89%)	7.23% (2.60-15.20%)

MVAs=motor vehicle accidents.

[a] Pooled OR (95%CI) from a meta-analysis of studies comparing MVA rates for people with and without OSAS.[15]

[b] Independent OR (95%CI) for being involved in a workplace accident over a 10-year period, for men who reported snoring and workplace sleepiness at the start of the study, compared to those who did not. Adjusted for age, BMI, weight gain, years at work, and other workplace exposures.[16]

[c] Independent OR (95%CI) for developing diabetes mellitus at 4-year follow-up, based on AHI at study start, (AH≥15 compared to reference group AHI<5 at study start). Adjusted for age, sex, and body habitus.[17]

[d] Independent ORs for the presence of hypertension at 4-year follow-up, based on AHI at study start, (reference group AHI=0 at study start). Low estimate is iOR for AHI=0.1–4.9, base case estimate is iOR for AHI=5–14.9, high estimate is iOR for AHI≥15. Adjusted for baseline hypertension status, BMI, neck and waist circumference, age, sex, and weekly use of alcohol and cigarettes.[18] These values were used in the absence of reliable estimates of the increased risk of CVD associated with OSAS.

The incidence of motor vehicle accidents on the road, and of other accidents, was estimated from 2005 Accident Compensation Corporation claims,[19] together with the national population data for 2005.[13] The prevalence of diabetes was taken from the data for New Zealand adults in 2002/03.[20] The base case was taken as the average prevalence for males and females in the total population (4.1%). The high value was the average prevalence for Pacific people (10.0%) and the low value was the average prevalence for non-Pacific, non-Māori people (2.9%). The prevalence of cardiovascular disease (CVD) was derived from the data for New Zealand adults in 2003/03.[20] The base case was taken as the average prevalence for males and females in the total population (9.0%). The high value was the average prevalence for Māori (12.1%) and the low value was the average prevalence for Pacific people (6.9%).

Resource utilisations—At each node in the outcome tree, events occur and resources are consumed. For example, a person with diabetes may consult a general practitioner, have prescriptions dispensed, and incur loss of earnings and transport costs. These resource utilisations are summarised in Table 2.

Cost estimates—Costs were categorised as direct medical, direct non-medical, indirect, and intangible costs.[21] Both human capital and willingness to pay approaches were used to place a value on a human life. In addition, we calculated a direct medical cost per quality of life year (QALY) gained if OSAS was successfully treated.[22]

Only incremental costs (compared with the counterfactual) were included. For example, if a particular medical cost would have been incurred whether or not an accident happened, it was not included in the analyses. The timeframe was one year, so that discounting of costs and effects was not required. Unit cost estimates are summarised in Table 3 (excluding GST of 12.5%).

Table 2. Resource utilisations by event

Events →	1 Do not seek treatment					2 Treatment sought from general practitioner		Hospital clinic			Result of monitoring		
	No effect	Motor vehicle accident	Other accident	Diabetes	Cardiovascular disease	No action thought necessary	Referral to hospital clinic →	No action thought necessary	Monitoring →	Not OSA	Conservative therapies	Appliances	Surgery
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.2.1	2.2.2	2.2.2.1	2.2.2.2	2.2.2.3	2.2.2.4
Resources ↓							Units of resource utilised by event						
1 Direct medical													
1.1 General practitioner				2	2	1	1						
1.2 Hospital clinic consultation								1	1			2	2
1.3 Monitoring									1				
1.4 Appliances												1	
1.5 Surgery													1
1.6 Motor vehicle accident direct medical		1											
1.7 Other accidents direct medical			1										
1.8 Diabetes prescriptions				1									
1.9 Cardiovascular disease prescriptions					1								
2 Direct non-medical													
2.1 Transport private motor vehicle				2	2	1	1	1	2			2	2
2.2 Motor vehicle accident direct non-medical		1											
2.3 Other accidents direct non-medical			1										
3 Indirect													
3.1 Average hourly earnings				2	2	1	1	1	4			2	40
3.2 Motor vehicle accident indirect		1											
3.3 Other accidents indirect			1										
4 Intangible													
4.1 Motor vehicle accident intangible		1											
4.2 Other accidents intangible			1										

Table 3. Unit cost estimates

Cost item	Base case	Source
OSAS treatment direct medical		
General practitioner[a]	$37.43	Average adult consultation fee [23]
Respiratory medicine clinic	$222.22	Initial consultation fee for medical practitioner band III[24]
Sleep clinic diagnosis	$768.89	Clinic average (Dr Angela Campbell, personal communication).
Appliances	$468.97	Average cost to patient of CPAP device (some are subsidised; Dr Angela Campbell, personal communication, 2005)
Surgery[b]	$11,029.20	AR-DRG v 5.0 (based on 20% tracheotomy, 80% maxillofacial surgery) [25]
Untreated OSAS direct medical		
Motor vehicle accident on the road	$1,533.24	Average ACC payment for medical, hospital, public health acute, and dental services [19,26]
Other accident	$469.47	Average ACC payment for all other types of accident [19,26]
Diabetes medications (per person per year)	$769.63	12 prescriptions for control, 4 for monitoring glucose levels, plus prescription dispensing fees[27]
Cardiovascular disease medications (per person per year)	$86.49	4 prescriptions, plus prescription dispensing fees[27]
OSAS treatment direct non-medical		
Private motor vehicle transport for treatment and diagnosis	$6.20	Average reimbursement of 62 c/km for a 10 km round trip[28]
Untreated OSAS direct non-medical		
Motor vehicle accident	$2,306.71	Average costs for vocational and social rehabilitation and conveyance[19,26]
Other accident	$176.03	Average costs for vocational and social rehabilitation and conveyance[19,26]
Untreated OSAS indirect		
Production loss	$21.35	Average hourly earnings[29]
Motor vehicle accident	$2,735.01	Average income maintenance and independence allowances[19,26]
Other accident	$380.76	Average income maintenance and independence allowances[19,26]
Untreated OSAS intangible		
Motor vehicle accident	$831.48	Average weighted death benefit[19,26]
Other accident	$26.45	Average weighted death benefit[19,26]

[a] The cost of counselling or conservative therapy was assumed to be included in the consultation costs for the GP or at the respiratory medicine clinic.

[b] Surgical treatments for OSAS are changing, with tracheotomy becoming increasingly rare in this age group and gastric reduction becoming more common, particularly among patients who have private health insurance. Changes in the costings here do not make major differences to the total costings because of the very small proportion of patients receiving surgical treatments.

High and low values for each unit cost (except intangibles) were calculated as ± 25% of the base case rate. The high estimates for intangible costs associated with accidents were calculated by multiplying the willingness to pay for a statistical life ($2,830,000) [30] by the proportion of accidents causing death (for motor vehicle accident high=$28,239.93; for other accidents high=$1,235.92). The low estimates for intangible costs associated with accidents were calculated by multiplying one year's average earnings (lost due to death) by the proportion of accidents causing death (for motor vehicle accident low=$444.66; for other accidents low=$19.46).

Sensitivity analysis—The structure outlined in Figure 1 was represented in a spreadsheet model and 10,000 Monte Carlo simulations were run using randomly generated values between the high and low estimates for each model parameter. [31] Multiple linear regression was then used to evaluate the effects of each model parameter (independent variables) on the total direct and indirect costs, and the total costs calculated by the model.

Results

Table 4 summarises the estimated total base case societal costs of OSAS in New Zealand, for people aged 30–60 years.

Table 4. Total societal costs (base case) generated by OSAS (cost of illness)

Variables	Untreated (n=75,949)		Treated (n=18,987)		Total (n=94,936)	
	$ per case	$ total	$ per case	$ total	$ per case	$ total
Direct medical	142.84	10,848,785	649.63	12,334,604	244.20	23,183,190
Direct non-medical	66.79	5,072,686	14.12	268,049	56.26	5,340,735
Sub total direct	209.63	15,921,471	663.75	12,602,654	300.46	28,524,125
Indirect	115.09	8,741,271	66.40	1,260,719	105.36	10,001,990
Sub total direct + indirect	324.73	24,662,742	730.14	13,863,372	405.81	38,526,115
Intangible	16.50	1,253,360			13.20	1,253,360
Total cost	**341.23**	**25,916,102**	**730.14**	**13,863,372**	**419.01**	**39,779,475**

The incremental costs associated with untreated OSAS among people aged 30-60 years were estimated at $25.9 million per annum ($341 per case). The total costs of treatment were estimated at $13.9 million per annum ($730 per case). The total costs of OSAS were thus estimated at $39.8 million per annum (averaging $419 per case).

For 90% of the Monte Carlo simulations, the estimated total cost fell in the range $32.9-89.8 million, with the top three cost determinants being the prevalence of OSAS, and the cost and incidence of motor vehicle accidents. Figure 2 illustrates the breakdown of total base case costs. Lost productivity was the largest contributor to indirect costs, while the 3% of intangible costs relate to loss of life. Costs associated with accidents (motor vehicle and other) contribute 59% of the estimated total costs.

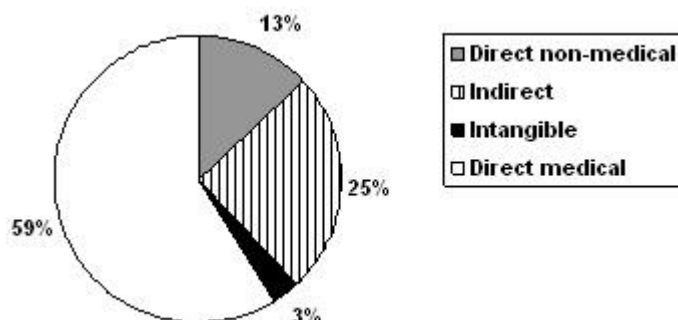**Figure 2. Breakdown of total base case costs of OSAS**

Table 5 shows the cost benefit and cost utility analysis for treating OSAS. It assumes a per case QALY gain of 5.4, with a low estimate of 0.10 and a high estimate of 8.00,[22,32] and that 20% of people with OSAS are treated (low value 15%, high value 25%), for a total gain of 102,531 QALYs per year.

Table 5. Net incremental direct medical cost per QALY gained by OSAS treatment

Incremental cost/benefit/outcome	$ per case	$ total	cases
Costs incurred	649.63	12,334,604	18,987
Costs avoided	142.84	2,712,196	
Incremental cost per case treated	506.79	9,622,408	

Discussion

Previous studies that have estimated the societal costs of sleep disorders have generally taken a top-down approach.[33,34] In contrast, the approach taken here using an outcome tree and decision analytic model yields a simulation tool that can be used to evaluate treatment options, and to estimate the economic impact of OSAS on different population groups. This is of particular interest, given the disproportionate burden of OSAS among Māori.[8–9]

For 2005, the estimated total annual societal costs of OSAS among New Zealanders aged 30–60 yrs was $39.8 million, with 90% of the Monte Carlo simulations in the range $32.9–$89.8 million. Limitations of the data used to inform these cost estimates need to be considered.

OSAS prevalence is a key determinant of total costs and the base case prevalence used (5.6%) was higher than the estimated 4% in an Australian community study of men [35] and 2–4% in the Wisconsin Sleep Cohort.[36] Using much more restrictive criteria for the definition of OSAS (RDI ≥5 plus ESS >10), we have recently estimated that the population prevalence of OSAS is 4.4% for Māori men, 4.1% for non-Māori men, 2.0% for Māori women, and 0.7% for non-Māori women.[8] However, we expect that these estimates are very conservative. The Monte Carlo simulations in the present study included prevalence estimates of 2.6–8.6%.

Estimates of the increased risks of comorbidities and accidents associated with untreated OSAS are based, in the main, on studies that have focused on populations with severe OSAS. These are the only data available to inform these estimates and their applicability to the general New Zealand population is unknown. The focus on severe OSAS could have resulted in over-estimation of the costs associated with untreated OSAS in the present study.

On the other hand, a number of factors would have tended to make our estimates of the costs of untreated OSAS conservative. Medical costs would have been higher if hospital inpatient costs of cardiovascular disease and diabetes were included, and if a broader range of diseases had been included for which OSAS is a possible risk factor.

Our estimate of indirect costs included lost productivity for time off work but not absenteeism or low productivity while working.

Indirect and intangible cost estimates were based on ACC payments.[19] However, the ACC database includes only those accidents for which claims were lodged, and which were judged as compensable under the scheme, so the incidence estimates are conservative and the costs represent the standards applied by the scheme, not necessarily all costs resulting from accidents.

The estimate of intangible costs is likely to be low because only those accidents causing death were quantified in dollar values. No attempt was made to quantify additional costs borne by family members as a result of living with an untreated OSAS sufferer (for example reduced productivity associated with having their sleep disturbed, or additional caregiving).

The outcome tree was based on patient trajectories in the Wellington region and may not be fully applicable to the variety of urban and rural settings in New Zealand, particularly since decisions on service provision are made at the level of district health boards, and services are not homogeneous nationwide.[7] The profile of patients referred by GPs to the hospital screening clinic may be unrepresentative, since GPs who are better informed about OSAS may be more likely to make referrals.

The incremental direct medical cost per QALY gained by OSAS treatment was estimated to be $94 (5th percentile $56, 95th percentile $310). From 1998–2005, decisions made by PHARMAC reflected an average cost per QALY gained of $6865.[37] Thus, this economic analysis strongly supports the cost effectiveness of OSAS treatment by comparison with pharmaceutical treatments that the government already funds for other conditions.

A survey in late 2006 found that 12 of the 21 District Health Boards had a specified budget for the management of sleep-related breathing disorders, with the remaining 9 DHBs having referral pathways to other DHBs.[7] The estimated number of sleep studies conducted (including laboratory-based and home-based polysomnographic studies and partial sleep studies without polysomnography), totalled 50/100,00 per year.

By comparison, for Australia the average was estimated at 282/100,000, for Canada 370/100,000 and for the USA 427/100,000.

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References:

1. American Sleep Disorders Association. International classification of sleep disorders, revised: diagnostic and coding manual. Rochester, Minnesota: American Sleep Disorders Association, 1997.

2. Young T, Peppard PE, Gottlieb DJ. Epidemiology of obstructive sleep apnea: a population health perspective. Am J Respir Crit Care 2002;165:1217-39.

3. Marin JM, Carrizo SJ, Vicente E, Agusti AG. Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study. Lancet 2005;365:1046-53.

4. Ip M, Mokhlesi B. Sleep and glucose intolerance/diabetes mellitus. Sleep Med Clin 2007;2:19-29.

5. Wittmann V, Rodenstein DO. Health care costs and the sleep apnea syndrome. Sleep Med Rev 2004;8:269-79.

6. Thoracic Society of Australia and New Zealand (New Zealand Branch). Standards for Adult Respiratory and Sleep Services in New Zealand. 2004. http://www.moh.govt.nz/moh.nsf/0/3F4D73A41FC31FFACC256F8F00056061/$File/standard sforadultrespiratoryandsleepservices.pdf

7. Garrett J, Chen B, Taylor DR. A survey of respiratory and sleep services in New Zealand undertaken by the Thoracic Society of Australia and New Zealand (TSANZ). N Z Med J. 2009;122(1289). http://www.nzma.org.nz/journal/122-1289/3456

8. Mihaere KM, Harris R, Gander PH, et al. Obstructive sleep apnoea in New Zealand adults: Prevalence and risk factors among Māori and non-Māori. Sleep 2009;32:949-956.

9. Mihaere K, Gander P, Reid P, et al. Prevalence of obstructive sleep apnoea amongst adult Māori and non-Māori in a New Zealand community sample. Sleep 2003;26 (Abstract supplement):A237.

10. Mihaere K. Obstructive sleep apnoea in Aotearoa/New Zealand: an objective and questionnaire-based approach to population prevalence and clinical screening. PhD in Public Health Thesis. Wellington, Massey University, 2004.

11. Frith RW, Cant BR. Obstructive sleep apnoea in Auckland: diagnosis and treatment. N Z Med J. 1985;98:745-8.

12. Baldwin DR, Kolbe J, Troy K, et al. Comparative clinical and physiological features of Māori, Pacific Islanders and Europeans with sleep related breathing disorders. Respirology 1998;3(4):253-60.

13. Statistics New Zealand. Estimated Resident Population of New Zealand at 30 June, 2005. http://stats.govt.nz

14. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep 1997;20(9):705-6.

15. Sassani A, Findley LJ, Kryger M, et al. Reducing motor-vehicle collisions, costs, and fatalities by treating obstructive sleep apnea syndrome. Sleep 2004;27(3):453-8.

16. Lindberg E, Carter N, Gislason T, Janson C. Role of snoring and daytime sleepiness in occupational accidents. Am J Respir Crit Care Med 2001;164(11):2031-5.

17. Reichmuth KJ, Austin D, Skatrud JB, Young T. Association of sleep apnea and type II diabetes: a population-based study. Am J Respir Crit Care Med 2005;172(12):1590-5.

18. Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep-disordered breathing and hypertension. N Engl J Med 2000;342(19):1378-84.

19. Accident Compensation Corporation. Accident Compensation Corporation: Annual Report. 2005. http://www.acc.co.nz

20. Ministry of Health. A Portrait of Health: Key Results of the 2002/2003 New Zealand Health Survey. Wellington : New Zealand Ministry of Health; 2004. http://www.phac.health.govt.nz/moh.nsf/0/3D15E13BFE803073CC256EEB0073CFE6

21. Kielhorn A, Graf von der Schulenburg JM. The health economics handbook. 2nd Edition ed. Chester: Adis; 2000.

22. Sleep Alliance. Sleep SOS report the impact of sleep on society. 2004. http://www.rospa.com/roadsafety/info/sleep.pdf

23. Statistics New Zealand. Consumers Price Index December 2005 quarter. 2005. http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/web/Hot+Off+The+Press+Consumers+Price+Index+December+2005+quarter?open

24. Southern Cross Medical Care Society. VIP Plan 4 Schedule of Benefits. 2005. http://www.sxbrokers.co.nz/sx_broker/library/x58218_3.pdf

25. Ministry of Health. Hospital throughput 2002/03. Wellington : New Zealand Ministry of Health; 2004. http://www.moh.govt.nz

26. Accident Compensation Corporation. Request for National Safety Audit 2005. Wellington: Accident Compensation Corporation; 2006.

27. Pharmaceutical Management Agency of New Zealand. Latest Statistics. 2006. http://www.pharmac.govt.nz/latest_stats.asp

28. Inland Revenue Department. Motor vehicle reimbursing rates, in Internal Revenue Department Tax Information Bulletin. Wellington: Inland Revenue Department; 1996.

29. Statistics New Zealand. Employment Survey (December 2005 quarter): 2006. http://www.stats.govt.nz/products-and-services/info-releases/qes-info-releases.htm

30. New Zealand Ministry of Transport. The social cost of road crashes and injuries: June 2004 update. Wellington: New Zealand Ministry of Transport; 2004.

31. Pallisade Corporation. Risk Analysis and Simulation add-in for Microsoft Excel. Pallisade Corporation: Newfield, NY, 2004.

32. Tousignant P, Cosio MG, Levy RD, Groome PA. Quality adjusted life years added by treatment of obstructive sleep apnea. Sleep 1994;17(1):52-60.

33. Tan M, Marra C. The cost of sleep disorders: no snoring matter. Sleep 2006;29(3):282-3.

34. Hillman DR, Murphy AS, Pezzullo L. The economic cost of sleep disorders. Sleep 2006;29(3):299-305.

35. Bearpark H, Elliott L, Grunstein R, et al. Snoring and sleep apnea. A population study in Australian men. Am J Respir Crit Care Med 1995;151(5):1459-65.

36. Young T, Peppard PE, Gottlieb DJ. Epidemiology of obstructive sleep apnea: a population health perspective. Am J Respir Crit Care Med 2002;165(9):1217-39.

37. Pharmaceutical Management Agency of New Zealand. Prescription for pharmacoeconomc analysis: methods for cost-utility analysis. Version 2. Wellington: Pharmaceutical Management Agency of New Zealand; 2006.