

Economics and Finances of Programs for Sleep Disorders

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Outline

- Obstructive sleep apnea (OSA) and insomnia cost-of-illness (COI)
- Utility of cost-of-illness studies
- What is cost-effectiveness analysis
- What do we know about cost-effectiveness of OSA and insomnia treatments?



OSA and Insomnia Cost/Burden-of-Illness (\$Billions)

	Direct	Accidents	Productivity Losses		Total
			Absenteeism	Presenteeism	
OSA	47-90	15-60	5-15	NE *	65-165
Insomnia					
Low †	11.0	NE		8.2	19.2
High ‡	39.5	32.3	11.8	63.0	146.6

NE = not estimated

References:


Apnea: Harvard Medical School Division of Sleep Medicine, The price of fatigue: the surprising economic costs of unmanaged sleep apnea

Insomnia (low): Estimates based on Sarsour, The association between insomnia severity and healthcare and productivity costs in a health plan sample

Insomnia (high): Estimates based on Ozminkowski, The direct and indirect costs of untreated insomnia in adults in the United States and Kessler, Insomnia and the performance of US Workers.




NOT SAYING ESTIMATES ARE
INCORRECT!!!



But Hard to Know That They Are....

- Major reason is that patients often have multiple illnesses, all of which may be contributing to same outcomes
 - e.g., patients with insomnia, OSA, prior CVD, hypercholesterolemia, hypertension, diabetes, and obesity
- What causes what?




Cost/Burden-of-Illness (\$Billions)

	Direct	Productivity	Total
Diabetes	176	69	245
CVD	193.1	123.5	316.6
Hypertension	45	3.6	48.6
Overweight / Obesity	147	3.4 – 6.4	150.4 – 153.4

- Has to be a lot of double counting here

References:
 Diabetes: ADA. Economic costs of Diabetes in the U.S. in 2012
 CVD and hypertension: AHA. Heart disease and stroke statistics—2016 update.
 Overweight/obesity: CDC. Adult obesity causes and consequences.



Double Counting

- OSA and insomnia?
 - Some patients have both, but unclear how much researchers do to allocate their costs to one or the other condition
 - Many studies funded by makers of medical therapies
 - Who's interested in a low number?
- OSA/insomnia, CVD, diabetes, obesity?
 - Some patients have all 5
- More generally, Bloom et al. have reported that sum of cost-of-illness of estimates of direct medical cost for 80 different diagnoses was 2 fold greater than annual US health expenditures

Bloom BS, Brumo DJ, Maman DY, Jayadevappa R. Usefulness of US cost-of illness studies....



ADA and AHA Are Trying

- ADA and AHA are some of the only organizations to make efforts to avoid double counting, but....
- When there are multiple causes (technically referred to as joint costs) methods for assigning costs to particular causes are arbitrary
- Typically don't have a gold standard for judging whether allocation methods are correct
 - Some costs may be truly joint and only avoided if all of the contributing factors are simultaneously eliminated



Implications of Double Counting

- Common to consider cost-of-illness estimates as measures of what can be avoided if we treat or cure a problem such as insomnia or OSA
- But if source of adverse outcomes is multifactorial, unclear how many adverse outcomes (and how much of their costs) can actually be avoided
 - e.g., if we successfully treat insomnia in a person who also is obese, has diabetes and high blood pressure, and has prior CVD, do we know how much cardiovascular disease – and its cost – we'll actually avoid?



BUT EVEN IF THE COI ESTIMATES ARE
CORRECT....



...They May Be Besides the Point!!!

- Investment decisions should depend on value, not magnitude of burden
 - How much do we have to pay to avoid burden and how much burden do we avoid?
- Learn about these trade-offs by use of cost-effectiveness analysis, NOT cost-of-illness studies



COST-EFFECTIVENESS ANALYSIS



Cost-Effectiveness Analysis

- Estimates costs and outcomes of intervention
- Costs and outcomes expressed in different units
 - Costs usually measured in money terms; outcomes in some other units



Cost-Effectiveness A Relative Measure

- Cost-effectiveness is a *relative* measure; no program is “cost-effective” in abstract
 - Results meaningful in comparison with:
 - A predetermined standard
 - e.g., \$50,000 - \$100,000 per quality-adjusted year of life saved
 - Other accepted and rejected interventions (e.g., a league table)



Cost-Effectiveness Ratios

- Cost-effectiveness ratio. e.g., CPAP vs No CPAP:

$$\frac{\text{Costs}_{\text{CPAP}} - \text{Costs}_{\text{NoCPAP}}}{\text{Effects}_{\text{CPAP}} - \text{Effects}_{\text{NoCPAP}}}$$

- A ratio can exist for every pair of options
 - 1 option (case series), no ratios calculated
 - 2 options, 1 ratio
 - 3 options, 3 ratios (option 1 versus option 2, option 1 versus option 3, and option 2 versus option 3)



COST-EFFECTIVENESS EFFECTIVENESS MEASURE



What Effectiveness Measure?

- Can calculate a ratio for any outcome
 - Cost per toe nail fungus day averted
- For cost-effectiveness ratios to be an informative, must know willingness to pay for outcome
 - In many jurisdictions – but not the US Congress – quality-adjusted life year (QALY) is recommended outcome of cost-effectiveness analysis



QALYS

- Economic outcome that combines preferences for both length of survival and quality into a single measure
- Help us decide how much to pay for therapies that:
 - Save fully functional lives/life years
 - VS
 - Save less than fully functional lives/life years
 - e.g., heart failure drug that extends survival, but extra time spent in NYHA class III
 - VS
 - Don't save lives/life years but improve function
 - e.g., heart failure patients spend most of their remaining years in class I instead of class III



QALY Scores

- QALY or preference scores generally range between 0 (death) and 1 (perfect health)
 - E.g., health state with a preference score of 0.8 indicates that year in that state is worth 0.8 of year with perfect health
 - There can be states worse than death with preference scores less than 0



CEA Example: Pietzsch, et al., No CPAP vs CPAP

- Lifetime projected results:

	COST	QALYs
– No CPAP,	\$217,000	10.81
– CPAP,	\$244,000	12.49
– Difference	\$27,000	1.68
- Cost-effectiveness “Table” incorporates these data plus the ratio of ΔC and ΔQ



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- Lifetime projected results:

	COST	QALYs
– No CPAP,	\$217,000	10.81
– CPAP,	\$244,000	12.49
– Difference	\$27,000	1.68
- Cost-Effectiveness table, difference in cost

	C_{NoC}	C_{CPAP}	ΔC	Q_{NoC}	Q_{CPAP}	ΔQ	C/Q
Pietzsch	217k	244k	27k				



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- CPAP,	\$244,000	12.49
- Difference	\$27,000	1.68

- Cost-Effectiveness table, difference in effect

	C_{NoC}	C_{CPAT}	ΔC	Q_{NoC}	Q_{CPAP}	ΔQ	C/Q
Pietzsch	217k	244k	27k	10.81	12.49	1.68	



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- Cost-Effectiveness table, cost-effectiveness ratio

	C_{NoC}	C_{CPAT}	ΔC	Q_{NoC}	Q_{CPAP}	ΔQ	C/Q
Pietzsch	217k	244k	27k	10.81	12.49	1.68	15.9k*

* 15.9k = 27k / 1.68; <50k-100k generally considered good value




WHAT DO WE KNOW ABOUT THE COST-EFFECTIVENESS OF OSA/INSOMNIA TREATMENTS?



IS CPAP COST-EFFECTIVE?




HAVE NEVER PERFORMED LONG-TERM COST-EFFECTIVENESS TRIALS, BUT ASSUMING CPAP DOES WHAT WE THINK IT DOES....



Markov: 5 (10)-Year Cost and QALYs, Nothing vs CPAP

	C_{No}	C_{CPAP}	ΔC	Q_{No}	Q_{CPAP}	ΔQ	C/Q
Mar '03 (€)	55	2719	2664	3.39	3.73	0.34	7861
Ayas (\$) *	1659	4177	2518	1.47	2.22	0.75	3354
Mar '06 (€)	-	-	6000	-	-	1.09	5480
Tan (\$C) *	266	2983	2717	1.47	2.22	0.75	3636
Sadatsafavi	4216	6401	2185	3.34	3.50	0.16	13,698
Pietzsch (\$) *	70k	80k	9500	5.67	6.26	0.59	16,172


All less than \$50k/QALY




Lifetime Cost and QALYs, Nothing vs CPAP

	C_{No}	C_{CPAP}	ΔC	Q_{No}	Q_{CPAP}	ΔQ	C/Q
Mar (€)	591	7902	7311	12.90	14.38	1.48	4938
Guest (£)	10645	9672	-973	7.22	8.09	0.87	DOM
Weatherly (£)	8140	9301	1061	11.93	12.39	0.46	2524
Pietzsch (\$)	217k	244k	27k	10.81	12.49	1.68	15,915
Tan (\$)	62.4k	66.2k	3800	10.3	11.3	1	3900

All less than \$50k/QALY



IS HOME DIAGNOSIS AND CPAP TITRATION COST-EFFECTIVE COMPARED WITH IN-LAB DIAGNOSIS AND TITRATION?




In Lab vs Home Diagnosis/CPAP Titration

	C_{Home}	C_{Lab}	ΔC	Q_{home}	Q_{Lab}	ΔQ	C/Q
Chervin (\$)	3460	4210	750	3.955	4.019	.064	11,719
Deutsch (\$)	4096	4866	790	2.23	2.33	.1	7900
Kim (\$)	1575	1840	264*	Equivalent			Dom
Atwood (\$)	4057	4621	564*	Equivalent			Dom

* P < 0.05; Dom: less expensive and same or better outcomes

Newer studies indicate home testing cheaper and as effective; older studies indicated in-lab cost-effective

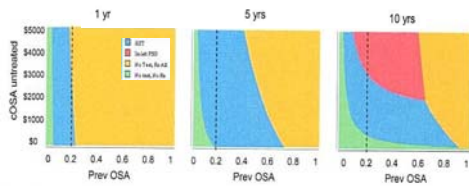


WERE PRE-TEST PROBABILITIES SO HIGH THAT NO ONE SHOULD HAVE BEEN TESTED?

DO LOWER PRE-TEST PROBABILITIES CHANGE RECOMMENDATION?



Moro Home vs In-Lab Comparison



- When costs and effects modeled out to 5 years, no role for in-lab testing
- When costs and effects modeled out to 10 years, in-lab has role only if annual cost of untreated OSA > \$2000 and pre-test probability between 10% and 60%

Moro M, et al. Decision modeling in sleep apnea. J Clin Sleep Med. 2016;12: 409




IS TELE-HOME FOLLOW-UP COST-EFFECTIVE?

Current evidence is equivocal




Telemedicine OSA Follow-Up							
	C _{Tele}	C _{FTF}	ΔC	Q _{Tele}	Q _{FTF}	ΔQ	C/Q
Isetta							
Total Cost	164	180	16*	.011	.012	.001*	13.3k
Sleep-related	115	151	36†	.011	.012	.001*	30.3k


• * NS; † p = 0.05
 • Telemedicine group experienced significantly lower travel time for therapy (8.6 vs 23.3 minutes) and time out of work (21.1 vs 55.0), but more nurse visits (24 vs 10)



CBT FOR INSOMNIA							
CBT FOR INSOMNIA							



CBT for Insomnia							
	C _{No}	C _{CPAP}	ΔC	Q _{No}	Q _{CPAP}	ΔQ	C/Q
Bonin (CBT)	72	251	179	--	--	.004	£44.8k
Morgan	142.6	272.4	130*	-.014	.024	.038	£3.4k



Summary

- There is a large literature on the cost-effectiveness of diagnosing and treating OSA and insomnia
 - Point estimates from this literature generally indicate that treatments for OSA and insomnia are cost-effective
- Little to none of literature based on randomized outcome studies of long-term effects of diagnosis and treatment
- Potential co-determination of outcomes and selection bias in long-term observational samples makes it difficult to estimate magnitude of treatment effects
- But **MUST** make decisions based on current knowledge base
 - Current estimates may be best we have!!!