

Positive Airway Pressure (PAP) Therapy In Obstructive Sleep Apnea (OSA): Modelling Of 20 Year Mortality And Hospitalizations

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BACKGROUND AND RATIONALE

To date, large randomized trials have not demonstrated mortality or cardiovascular event reduction with PAP therapy in OSA patients^{1,2,3} However, real-world data indicate that greater adherence to PAP therapy correlates with reduced cardiovascular events, highlighting limitations in trial generalizability due to stringent patient selection and low adherence^{4,5} Economically, CPAP has shown cost-saving benefits through reduced emergency visits and hospitalizations, proving cost-effective in various countries^{6,7}. Yet, cost-effectiveness studies in Germany remain lacking, reflecting a focus on clinical over economic ⁸. Analysis of an observational German public health insurance database, using propensity score method⁹ has suggested substantial potential reductions in all-cause mortality and hospitalizations over 4 years among OSA patients treated with PAP therapy. This study applied the previously estimated effects of PAP therapy to estimate potential long-term benefits.

METHODS

Model Structure: A model based on the PATHOS study¹⁰ was developed to estimate life expectancy, hospitalization rates, and CPAP treatment costs for people with OSA over a 40-year horizon, using quarterly cycles. The model applies German life tables adjusted for OSA-related excess mortality to estimate survival for untreated patients and compares these with PATHOS-observed survival rates.

Model population: Mean age was 58 years, with 28% being female

Mortality Analysis: All-cause mortality for CPAP-treated vs. untreated patients was calculated using Cox proportional hazards models that adjusted for baseline differences, including age, gender, Charlson Comorbidity Index, and propensity scores. A hazard ratio from PATHOS^{9,10} was applied for mortality reduction in CPAP-adherent patients, assuming 90% adherence.

Adherence & Discontinuation: Adherence and discontinuation estimates were based on German¹¹ and Swiss studies¹². Initial discontinuation (11.9%) was adjusted to match PATHOS demographics¹³. Long-term adherence data informed rates of 7.1% discontinuation over the first five years and 1.5% annually thereafter.

Hospitalization Rates: Hospitalization data from PATHOS⁹were used to calculate a baseline annual rate of 6.5% for untreated patients, with a 19% relative reduction in the CPAP group.

Scenario Analyses: The model evaluated alternative scenarios, including age at treatment start, varying adherence, and different assumptions regarding treatment effects, allowing for robust analysis of potential long-term benefits and cost impacts of CPAP in diverse patient profiles. Inputs to the analysis, including the assumptions described above, are summarized in Table 1.

Table 1: Model inputs

Variable	Description	Input value	Scenario analysis range		Source
			min	max	
Age (years)		58	50	70	Ref ¹³
Female		28%	N/A		
Mortality	Rate ratio OSA	3.15	2.5	5	German life tables; Ref ^{9,10}
	HR CPAP	0.85	0.724	0.997	Ref ^{9,10}
Discontinuation	Year 1	11.96%	0.1	0.14	Ref ^{9,10,11}
	Year 2-5	6.83%	N/A		Ref ¹² assumption
	Year 5+	1.50%	N/A		
Hospitalization	Rate per annum	6.55	5.24	7.85	Ref ^{9,10}
	OR CPAP	0.81	0.74	0.89	Ref ^{9,10}
CPAP Adherence	Relative to PATHOS	1	0.6	1	assumption

RESULTS

- PAP therapy was modeled to potentially avoid substantial numbers of deaths and hospitalizations.
- Over a period of 10 years, it is projected that PAP therapy could avert 1,800 deaths, gain 0.088 life years, and avoid 7,559 hospitalizations per 100,000 patients (Table 2).
- Extending the period to 20 years, the benefits increase significantly, with an estimated 3,362 deaths averted, 0.356 life years gained, and 10,249 hospitalizations avoided per 100,000 patients
- Over the full 40-year time horizon of the model, representing potential lifetimes for patients with the average PATHOS study characteristics, this increase in survival would represent an average extension of life of approximately 0.71 life years, or 0.41 with annual discounting

Table 2: Summary base case results

Outcome	Years	Usual care	CPAP	Deaths averted/100,000	Hospitalizations avoided/100,000
Survival	4 years	0.922	0.947	700	3,897
	10 years	0.809	0.827	1800	7,559
	20 years	0.469	0.503	3362	10,249
Life years	undiscounted	18.45	19.16	NA	
	discounted	13.54	13.95		

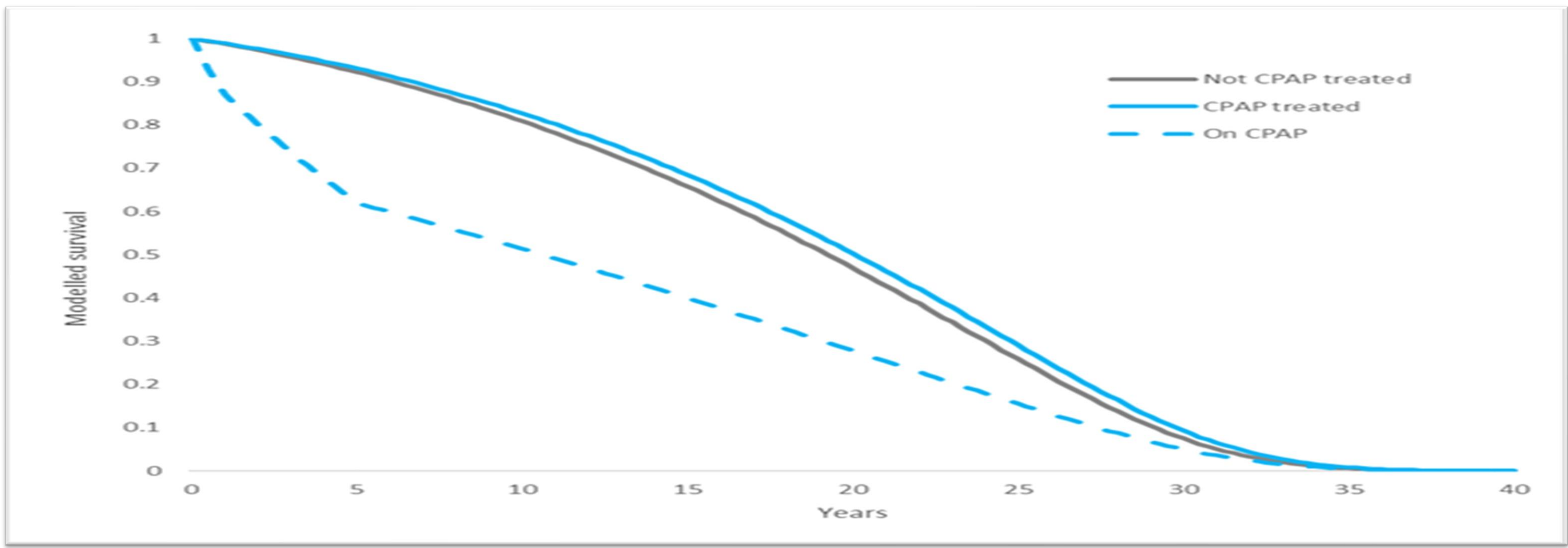
- The results of scenario analyses (**Table 3**) are as follows:
 - Starting treatment at age 70 yields fewer life-year gains but avoids more short-term deaths
 - Higher short-term discontinuation decreases survival gains
 - Lower OSA mortality reduces CPAP survival gains & higher mortality leads to more deaths avoided with reduced life expectancy gains
 - The hazard ratio confidence interval (0.72–1.00) shows survival benefits only at lower limits.
 - Hospitalization rates, which were not linked to mortality in the model, showed a wide range, with minimal effect on survival projections.

Table 3: Scenario Analysis

Variables	Deaths avoided ^a		Hospitalizations avoided ^a		Life years gained
	10 yrs	20 yrs	10 yrs	20 yrs	
Age (70)	3182	1308	4481	3787	0.35
Higher discontinuation yr 1 (0.14)	1757	3282	7388	10000	0.4
Lower OSA mortality (RR 2.50)	1486	3083	7839	11206	0.39
Higher OSA mortality (RR 5.00)	2542	3534	6822	8071	0.44
Lower HR mortality (0.742)	3349	6469	7161	8566	0.79
Lower hospitalization rate	b	b	6047	8199	b
Higher hospitalization rate	b	b	9071	12299	b
Lower hospitalization OR	b	b	10667	15194	b
Higher hospitalization OR	b	b	4007	4598	b

^aper 100,000 over 10 years; ^bno impact, HR: Hazard ratio; OR: Odd ratio

- Figure 1 shows the modelled survival on CPAP over the course of the analysis, along with modelled actual survival



CONCLUSIONS

- CPAP treatment for OSA is expected to substantially reduce deaths and hospitalizations over a 20-year period, improving life expectancy.
- The public health benefits of CPAP underscore its value in OSA management protocols.
- While subject to the usual limitations relating to observational data, a simple extrapolation of the benefits seen over 4 years in the German data suggests health benefits from PAP therapy could be comparable with those seen in areas such as hyperlipidaemia, hypertension, and diabetes in Germany (Gill et al.2024)
- It is therefore imperative that secondary prevention measures, which could include CPAP in people with OSA, are prioritized.

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