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RESEARCH ARTICLE

Ten-year projection of adult epilepsy burden in Australia

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Abstract

Objective: The World Health Organization's Intersectoral Global Action Plan on Epilepsy and Other Neurological Disorders calls for more epilepsy care centers, but a population-level estimate of epilepsy's projected burden to justify this investment from a societal perspective is lacking. We aimed to project the burden of epilepsy using dynamic life table modeling including number of deaths, years of life, quality-adjusted life years (QALYs), productivity-adjusted life years (PALYs), health care costs, and number of people to be screened for surgical eligibility in the Australian adult population (aged 18–80 years) from 2024 to 2033.

Methods: A dynamic model was developed to capture incident and prevalent epilepsy in Australia, using five health states: not seizure-free non-drug resistant (NSF-NDRE), seizure-free non-drug resistant (SF-NDRE), not seizure-free drug resistant (NSF-DRE), seizure-free drug-resistant (SF-DRE), and death in 1-year cycles. The inputs came from published studies, Glosgow cohort study and from the Australian Epilepsy Project.

Results: In 10 years, 82 723 Australian adults had incident epilepsy, whereas 125 223 formed the prevalent cohort. Over 10 years, the epilepsy population

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Gopisankar Mohanannair Geethadevi and Kristoffer Jarlov Jensen contributed equally to this work.

Australian Epilepsy Project Investigators are presented in Appendix A.

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experienced 15 227 deaths and accrued 1 209 280 years of life, distributed as 23.6% NSF-NDRE, 58.3% SF-NDRE, 15.8% NSF-DRE, and 2.1% SF-DRE. The population accrued 992 812 QALYs and 442 600 PALYs. Total health care costs reached $14.2 billion US dollars (USD), of which NSF-DRE contributed 35%. Uncontrolled seizures resulted in the loss of 84 881 QALYs, 19 333 PALYs, $4.5 billion USD, and 4603 lives. A total of 10 665 individuals were eligible for surgical evaluation, with an additional 383 projected annually through 2033.

Significance: This dynamic life table model, based on the current standard of care for epilepsy, demonstrates quality of life impact, productivity loss, and cost burden due to uncontrolled seizures and drug resistance, supporting the need for further investment in epilepsy care. This approach can be applied to other countries to inform policy decisions in epilepsy from a societal perspective.

KEYWORDS

costs, epilepsy, model, productivity, quality of life

1 | INTRODUCTION

The World Health Organization (WHO)'s 2022 Intersectoral Global Action Plan on Epilepsy and other Neurological Disorders recommends strategic action to strengthen the public health approach to epilepsy by improving service coverage and establishing more epilepsy care services.[1] Various national and international agencies also advocate for establishing comprehensive epilepsy care centers to provide specialized care to people with epilepsy.[2] Even as a high-income country, Australia faces a shortage of workforce available to deliver such epilepsy care,[3] especially considering that .6% of Australians are currently living with epilepsy[4] and 4% are expected to develop it in the future.[5] The majority of the workforce operates in major cities, exacerbating this shortage in regional and rural centers.[6] There is a need for the development of coordinated and shared care centers between different levels of health care services to address these deficiencies, in line with the WHO action plan.[7]

Establishing such centers comes with a cost, and such an effort should stay within the available budget. Australia spent approximately $239 million US dollars (USD) on epilepsy care in 2018–2019, which represented only .2% of health expenditures.[8] As of 2023, 21 public health hospitals across Australia operated epilepsy units for people with drug-resistant epilepsy, a subgroup with higher morbidity.[9] Quantifying the burden of a standard of care (SOC) model in Australia is crucial for financial planning, as well as for assessing the cost-effectiveness of new projects on epilepsy care.

Key points

- A decade of epilepsy accrued 15 227 deaths, 992 812 quality-adjusted life years, 442 600 productivity-adjusted life years, and $14 billion in cost.
- Uncontrolled seizures took 84 881 quality-adjusted life years, 19 333 productivity-adjusted life years, $4.5 billion in cost, and 4603 lives.
- Drug-resistant epilepsy accounted for 36% of the total health care costs, despite only comprising 18% of the total years lived.
- Potential candidates for surgical screening would be 10 655 in 2024, with a projected increase of 383 patients per year until 2033.

Previous studies have estimated the prevalence, incidence, mortality, productivity, and costs of epilepsy across various countries and contexts.[10–15] Although various modeling approaches exist, budget-level analyses require a comprehensive integration of components that consider the SOC for epilepsy along with the projected incidence and prevalence. This approach is widely used by the Australian Pharmaceutical Benefits Advisory Committee to assess costly treatments based on estimated use, financial implications, and total expenses.[16] Currently, no single model combines population-level measures—such as epilepsy prevalence, incidence rates, mortality in epilepsy, and the number of individuals eligible for curative surgery—with health economic metrics like quality-adjusted life years (QALYs), productivity-adjusted life years (PALYs), and total health care costs. A baseline model is essential for policymakers to make

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informed decisions by comparing current health care expenses related to the disease, with the potential impact of new interventions. It allows for an evaluation of overall costs and the return on investment, helping to determine whether a proposed intervention would lead to meaningful cost savings and improved outcomes. Additionally, defining clinically meaningful health states, particularly drug resistance and yearly seizure freedom status, is essential.[17] Furthermore, changes in the population over time, influenced by fluctuations in immigration levels, birth rates, and death rates, become increasingly relevant. This limitation impedes the ability to perform a full-scale budget impact analysis aligned with the WHO action plan.

We developed a dynamic life table modeling approach to project the current management setting over the next 10 years. The model aimed to quantify the number of deaths, QALYs, PALYs, total health care costs, and surgical evaluation burden in the adult epilepsy population, as well as to estimate the burden due to uncontrolled seizures and drug resistance.

2 | MATERIALS AND METHODS

We developed two dynamic life table models to estimate the total number of people (aged 18–80 years) living with epilepsy, which were combined to form the SOC model. One model followed all adult incident cases from 2024 to 2033, whereas the other tracked the estimated prevalent cohort in 2024 through to 2033. Both models calculated number of deaths, years of life (YLs), QALYs, PALYs, health care costs, and number eligible for surgical evaluation stratified by sex and age (18–80 years). People with epilepsy were placed in four health states (besides death), and the cycle length was 1 year, which was adjusted for half-cycle correction, with a 5% discount rate for outcomes as per Australian guidelines.[18] Model inputs are summarized in Table S1. Two cohort studies were used for this study: data from the Australian Epilepsy Project (AEP),[19] an ongoing prospective cohort study, and the Glasgow cohort study,[20] a completed study.

The AEP project (HREC/68372/Austin-2022) was approved by the Human Research Ethics Committee at Austin Health in June 2022. The informed consent requirement for the Glasgow study was waived by the institutional review board of Western Infirmary, Glasgow, as all data were deidentified prior to analysis for clinical audit and quality assurance purposes.

The models were developed independently in parallel using Excel 2016 (Microsoft Corporation) and Statistical Analysis Software version 9.4 (SAS Institute), respectively, and the main model results were validated across both platforms.

2.1 | Health states and transition probabilities

From a cohort study of 1795 patients with newly diagnosed epilepsy followed between 1982 and 2014 at a center in Glasgow, Scotland,[20] we derived two major components for the model:

1. Health states: During the follow-up, the study recorded their yearly seizure status and determined whether they had developed drug resistance in that year. Based on this information, four health states were derived to categorize all people with epilepsy into one of these states in a given year (see Figure S1), which included:
   - (i) Not seizure-free and non-drug-resistant epilepsy (NSF-NDRE)
   - (ii) Seizure-free and non-drug-resistant epilepsy (SF-NDRE)
   - (iii) Not seizure-free and drug-resistant epilepsy (NSF-DRE)
   - (iv) Seizure-free and drug-resistant epilepsy (SF-DRE)
2. Transition through these health states: All participants in the Glasgow study went through SOC treatment based on their seizure type, adverse drug effects, and interaction profiles, which resulted in changes to their health states. We tracked these changes (transition probabilities) over a 10-year period. The observed transition probabilities were then applied to the entire cohort of individuals with epilepsy in Australia, assuming they would follow the same trajectory prospectively if they received the same SOC treatment.

In Australia, people who experience seizures commonly seek medical attention via their general practitioner (GP) or their local emergency department. Epilepsy may be diagnosed at that time, or the patient may be referred for investigations and/or specialist review with a neurologist. Patients must have a referral letter from their GP to receive a Medicare subsidy (universal health care program) for the cost of their specialist appointment.

Our model starts at the point of diagnosis. After this, individuals can transition between all health states. However, in the clinical pathway, if seizures remain uncontrolled, the patient is referred to an epilepsy specialist center for advanced diagnostics and treatment options like surgery or neurostimulation. We parameterized this as a transition to drug resistance, where individuals can

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only move between SF and NSF states and can no longer revert to the NDRE state. Assuming all DRE patients with focal epilepsy were eligible for surgical evaluation,[21] transition probabilities were separately derived to estimate the number needing screening. In other words, we are modeling the SOC to the whole epilepsy population in Australia.

2.2 | Incident and prevalent models

The model utilized population projections for 2024 provided by the Australian Bureau of Statistics (ABS) as the baseline cohort.[22] We used the medium series population projection estimate to determine the age–sex (18–80 years) population in Australia. To derive the number of people with newly diagnosed epilepsy every single year, age-based incidence rates were applied to this cohort. We found no population-level data on age-specific epilepsy incidence rates in Australia. Instead, we employed age-based incidence rates from a large electronic health record-based database in England, which was the most conservative estimate.[23] Due to the lack of population-specific data on the distribution by health states and time since diagnosis of people living with epilepsy in Australia, we modeled a virtual prevalent cohort by simulating annual incident cases from 2004 to 2023, using the same age–sex-specific incident rates as the incident model, applied to the annual Australian population estimates. The simulated cohort was then cycled annually using transition probabilities and health state-specific mortality rates, also matching those of the incident cohort. The resulting proportions for each health state and time since diagnosis were applied to the 2023 prevalent cohort based on a national health survey by ABS for 2017–2018.[24] The incidence and prevalence of focal epilepsy were kept as 45% and 46%, respectively. See Figure 1 for the complete model.

2.3 | Mortality estimates

We derived the age–sex- and health state-dependent mortality of NSF (Notes S1) from a cohort study from three specialist tertiary hospitals in Australia with 10-year follow-up.[25] The mortality of the SF-NDRE and SF-DRE health states was assumed to be equivalent to the general population utilizing ABS 2021 data,[26] as seizure freedom status was reported to be of no excess all-cause mortality.[27–29]

2.4 | YLs and QALYs

The model's 10-year horizon (2024–2033) calculated the number of people in each health state by year, sex, and age. A half-cycle correction was applied, halving the person count in the first cycle for new diagnoses, and similarly adjusting subsequent cycles by halving the difference in person counts between cycles within the same age–sex–year cohort and health state. The utility values for the SF states were assumed to be equivalent to general population estimates derived from an Australian study, reporting age- and sex-specific mean EuroQol five-dimension five-level scale values.[30,31] The mean (SD) utility values for NSF were taken from the baseline results of the AEP ($n = 653$), which were .73 (.23) for NSF-NDRE and .68 (.26) for NSF-DRE. The mean utility values were multiplied with the YLs to derive QALYs.

2.5 | Health care costs

The formal (hospital inpatient and outpatient costs, primary medical care by general practitioners, pathology and imaging costs, and pharmaceuticals) and informal (caregiver, transportation, and equipment costs) health care costs were calculated from estimates on the economic burden of epilepsy in Australia published in 2019 for the patient organization Epilepsy Australia.[32] The cost estimates were used, after adjusting for inflation to 2024 prices, to derive the cost for each of the health states. The variation in cost based on seizure status or drug resistance was not available for Australia. Thus, a systematic review, which reported that the costs of uncontrolled epilepsy ranged from 2.1 to 10.6 times that of SF epilepsy, was utilized.[33] Thus, we assumed the cost of NSF to be twice that of SF, and the cost of DRE as double as that of NDRE. Only age-based variation, and not sex-based differences, was observed in a US study, which we applied in the model (Notes S2 and S3).[34] The cost was estimated in Australian dollars (AUD) was converted (2023 purchasing power parity of 1.39) to USD for easy international comparison.

2.6 | Productivity-adjusted life years

PALYs are a new measure of the burden of disease that has been utilized to understand the effect of diseases on productivity loss based on absenteeism, presenteeism, premature workforce exit, and death.[35] PALYs required calculation of productivity index based on average annual working days and number of workdays lost (absenteeism) due to epilepsy. Data from an ABS survey[36] and a 2023 Australian survey report[35] provided the number of workdays for the general population and absenteeism (Notes S4). Absenteeism for NSF-NDRE and NSF-DRE was taken from the AEP study, and for SF-NDRE and SF-DRE it was assumed to be same as that of the general population. Productivity index was

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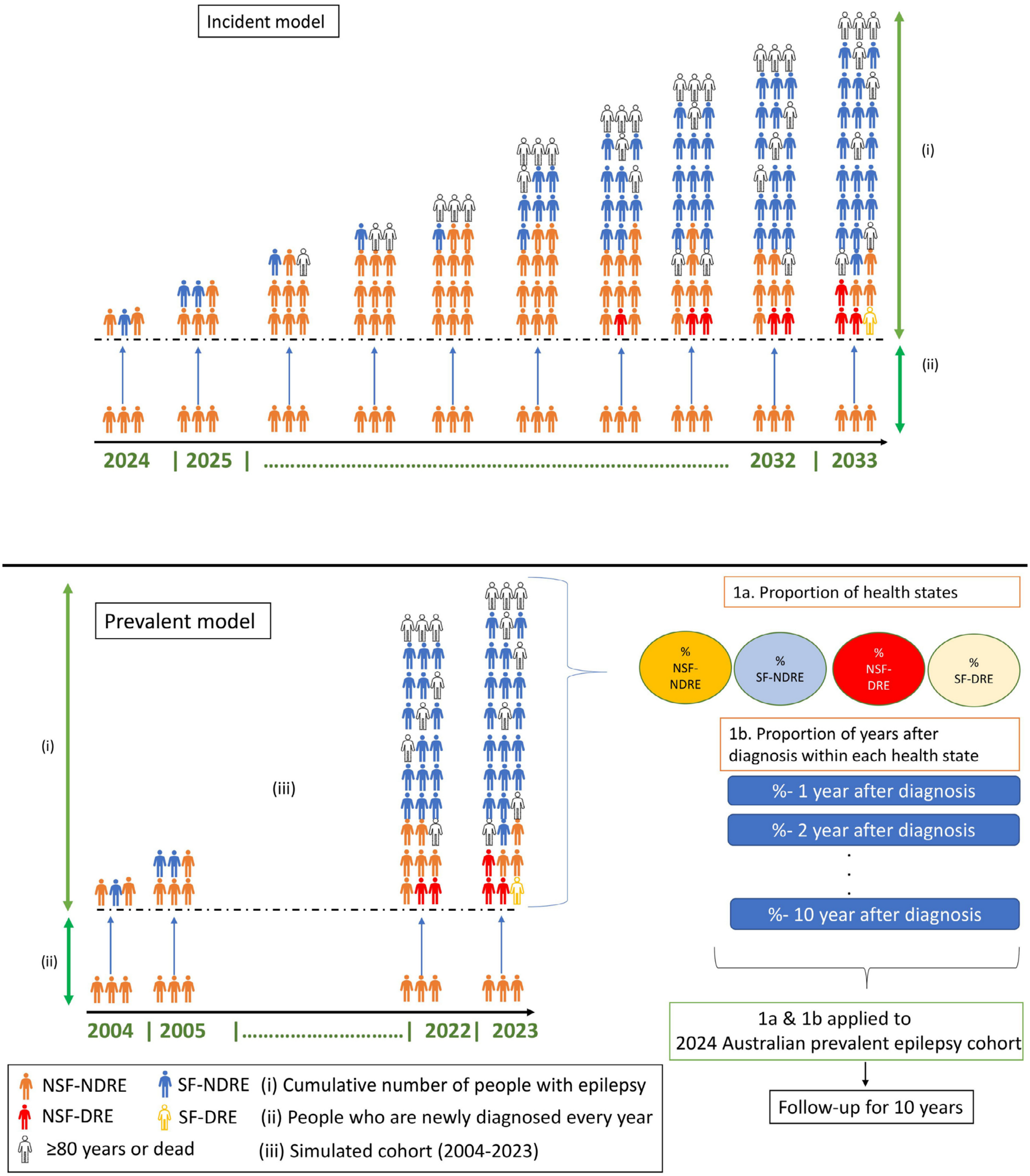

FIGURE 1 The incident and prevalent model of epilepsy. DRE, drug-resistant epilepsy; NDRE, non-DRE; NSF, not seizure-free; SF, seizure-free.

multiplied by YLs to derive the PALYs only for the working age group, which was 18–64 years in Australia.[37] A total of 395 participants from the AEP reported that the average (SD) number of work hours lost directly due to epilepsy per week was 4.7 (20) in NSF-DRE and 3.8 (9.2) in NSF-NDRE.

2.7 | Scenario analyses

To isolate the effects of DRE and NSF status on key outcomes, the inputs were adjusted to reflect NDRE and SF, respectively. This approach enabled the estimation of differences attributable solely to DRE status and SF. We also considered a scenario in which the cost of SF-DRE was assumed to be the same as that of SF–NDRE. To understand the effect of seizure resolution, a new term devised by the International League Against Epilepsy,[38] we applied a 5% yearly resolution rate, after consulting with the clinical experts, in the prevalence cohort for individuals in the SF health states (SF-DRE and SF-NDRE) who exceeded 10 years since diagnosis. We considered alternate inputs for Aboriginal and Torres Island people in Australia to derive the key outcomes of the models. The inputs are listed in Notes S5.

2.8 | Fitting the parameters to the sex- and age-specific life table model

Except for the annual Australian population estimates and the general mortality rates, which were given by age and individual age-year by its source, and transition probabilities, which we assumed to be age–sex uniform, we used polynomial regression models to interpolate age–sex-specific parameters from their original sources, using the polynomial model that provided the best fit.

3 | RESULTS

3.1 | Current SOC

Under the SOC, by the 10th year, the proportion of NSF-NDRE decreased by 47.3%, whereas SF-NDRE, NSF-DRE, and SF-DRE increased by 28%, 16.5%, and 2.7%, respectively, compared to the first year of diagnosis (Table 1). The highest variation (at least 70% of the total change) in proportions was observed within the first 2 years for all health states, except for SF-DRE, after which the trends stabilized. The simulated prevalent cohort indicated that 25% were classified as NSF-NDRE, 57% as SF-NDRE, 15% as NSF-DRE, and <1% as SF-DRE. When further stratified by time since diagnosis, individuals with follow-up beyond 10 years comprised the highest proportion within each health state.

TABLE 1 Proportions of alive health states based on current standard of care over time and proportions derived by the simulated prevalent model, both stratified by time since diagnosis.

Years since diagnosis	NSF-NDRE	SF-NDRE	NSF-DRE	SF-DRE
Change in proportion of alive health states in Glasgow cohort over time due to current standard of care				
1	67.85%	31.59%	.56%	.00%
2	44.61%	48.13%	7.09%	.17%
3	33.41%	54.10%	12.26%	.23%
4	27.64%	57.35%	13.88%	1.12%
5	24.80%	58.50%	14.95%	1.74%
6	23.96%	58.53%	15.54%	1.97%
7	22.78%	58.75%	16.25%	2.22%
8	21.73%	59.13%	16.56%	2.59%
9	20.52%	59.67%	17.07%	2.74%
10	19.34%	60.30%	17.54%	2.82%
Distribution of proportions of year since diagnosis and health state in prevalent cohort				
1	3.98%	1.89%	.04%	.00%
2	2.54%	2.80%	.41%	.01%
3	1.84%	3.09%	.69%	.01%
4	1.46%	3.20%	.79%	.06%
5	1.28%	3.20%	.83%	.09%
6	1.20%	3.14%	.85%	.10%
7	1.11%	3.10%	.87%	.12%
8	1.04%	3.05%	.89%	.13%
9	.97%	3.02%	.91%	.13%
10	9.17%	31.25%	9.32%	1.41%

Abbreviations: DRE, drug-resistant epilepsy; NDRE, non-DRE; NSF, not SF; SF, seizure-free.

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3.2 | Incident model

The total number of people with incident epilepsy was 82 723 between 2024 and 2033. This consisted of 42 127 (50.9%) females. The total number of deaths was 4343. The total number of YLs accrued was 272 699, with 38.7% from NSF-NDRE, 50.3% from SF-NDRE, 10.2% from NSF-DRE, and .8% from SF-DRE. The total QALYs accrued was 220 808, of which 34.9% was NSF-NDRE, 55.4% was SF-NDRE, 8.6% was NSF-DRE, and .9% was SF-DRE. The total PALYs were 95 540, of which 36.8% were from NSF-NDRE, 52.8% from SF-NDRE, 9.4% from NSF-DRE, and .9% from SF-DRE. The total health care cost over 10 years is expected to be $3.3 billion. The proportion of costs per health state were 46.9% for NSF-NDRE, 30.2% for SF-NDRE, 21.9% for NSF-DRE, and .9% for SF-DRE.

3.3 | Prevalent model

The total prevalent cohort entering 2024 numbered 125 223. This consisted of 65 911 (47.4%) females. The total number of YLs accrued was 936 581, with 180 482 (19.2%) from NSF-NDRE, 568 019 (60.6%) from SF-NDRE, 164 133 (17.5%) from NSF-DRE, and 23 947 (2.5%) from SF-DRE. The total number of deaths was 10 884. The total QALYs accrued over a decade were 772 004, of which 17.1% were NSF-NDRE, 65.5% were SF-NDRE, 14.6% were NSF-DRE, and 2.7% were SF-DRE. The total PALYs with the prevalent model were 347 060, of which 18.4% were from NSF-NDRE, 63.0% were from SF-NDRE, 15.8% were from NSF-DRE, and 2.6% were from SF-DRE. The total health care cost over time is expected to be $10.9 billion. The proportion of costs per health state was 23.0% for NSF-NDRE, 36.4% for SF-NDRE, 37.7% for NSF-DRE, and 2.7% for SF-DRE.

3.4 | Combined model

The combined results of the incident and prevalent models yielded a total of 15 227 deaths, 1 209 280 YLs, 992 812 QALYs, 442 600 PALYs, and $14.2 billion in total health care costs. Table 2 shows the age- and sex-stratified results. When the model was restricted to focal epilepsy

TABLE 2 Base case results (combined model) for age categories and sex.

Category, years	YLs	Deaths	QALYs	Cost	PALYs
All age groups	1 209 280	15 227	990 387	$19 846 583 950	434 660
Older adolescents					
18–19	25 527	46	21 804	$591 869 608	10 478
Young adults					
20–24	65 247	160	55 684	$1 412 122 902	33 249
Adults					
25–29	71 667	233	60 824	$1 410 490 073	41 009
30–34	84 221	285	70 806	$1 523 251 451	48 653
35–39	97 215	385	80 863	$1 633 217 914	54 828
40–44	107 562	488	88 651	$1 704 100 769	59 254
45–49	114 611	643	93 910	$1 739 611 977	60 890
50–54	130 025	961	106 278	$1 927 834 892	63 037
55–59	128 958	1346	105 182	$1 904 152 801	45 688
Older adults					
60–64	131 723	2031	106 872	$1 975 325 011	17 574
65–69	117 421	2814	94 077	$1 818 364 531	0
70–74	91 521	3471	71 925	$1 475 965 598	0
75–79	42 037	2227	32 344	$703 411 999	0
80	1544	137	1165	$26 857 157	0
Sex					
Male	614 156	10 256	507 706	$10 093 239 472	265 562
Female	596 554	5011	483 784	$9 778 481 532	169 440

Abbreviations: PALY, productivity-adjusted life year; QALY, quality-adjusted life year; YL, year of life lived.

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alone, the model yielded 553 381 YLs, 452 179 QALYs, $9 203 914 372, in health care costs, 198 673 PALYs, and 7012 deaths. The model estimated that in 2024, approximately 10 655 people with focal epilepsy and DRE were eligible for surgical workup, with this number increasing by an average of 383 people per year over the next 10 years (Figure 2).

3.5 | Scenario analyses results

Over a 10-year period, 19 333 PALYs, 84 881 QALYs, and 4603 lives were lost due to the presence of the NSF health state, along with an economic loss of $4.4 billion USD. Having a DRE health state resulted in $2.2 billion USD lost, 8593 QALYs lost, and 3491 PALYs lost (Table 3). Applying a 5% seizure resolution rate resulted in a 6.4% reduction in YL, 5.2% reduction in death, 6.9% reduction in QALY, 3.8% reduction in cost, and 6.6% reduction in PALY estimates compared to the base case. When SF-DRE was assumed to have the same cost as SF-NDRE, the total reduction in costs was 1.04% ($204 million AUD). Please see Table S2 for the sensitivity analysis around seizure resolution rates. Additionally, we have included the key outcomes for Aboriginal and Torres Island people in Australia in Notes S6.

4 | DISCUSSION

This dynamic life table model, which quantified the burden of epilepsy in Australian adults in the next 10 years, found several key points that substantiate further investment in epilepsy care. The model provided a 10-year projection of the number of adults in Australia developing and living with epilepsy, including detailed estimations of their YLs (1 209 280), deaths (15 227), QALYs (992 812), PALYs (442 660), and total health care costs ($14.2 billion) under the current SOC.

If the current SOC remains unchanged, the model predicts that majority of the total 10-year increase in seizure freedom for new onset epilepsy will occur within the first 2 years following diagnosis, with little additional progress beyond that period. Similarly, the greatest reduction in the yearly lack of seizure freedom is expected during the initial years, followed by stagnation beyond 3–4 years, resulting in a substantial annual loss of approximately 8488 QALYs, 19 333 PALYs, 460 lives, and $447 million USD in costs.

In parallel, drug resistance is projected to rise, with the highest increase occurring during the early period—up to 4 years—before leveling off thereafter. The transition to seizure freedom in DRE is expected to be minimal under the current SOC, meaning that individuals

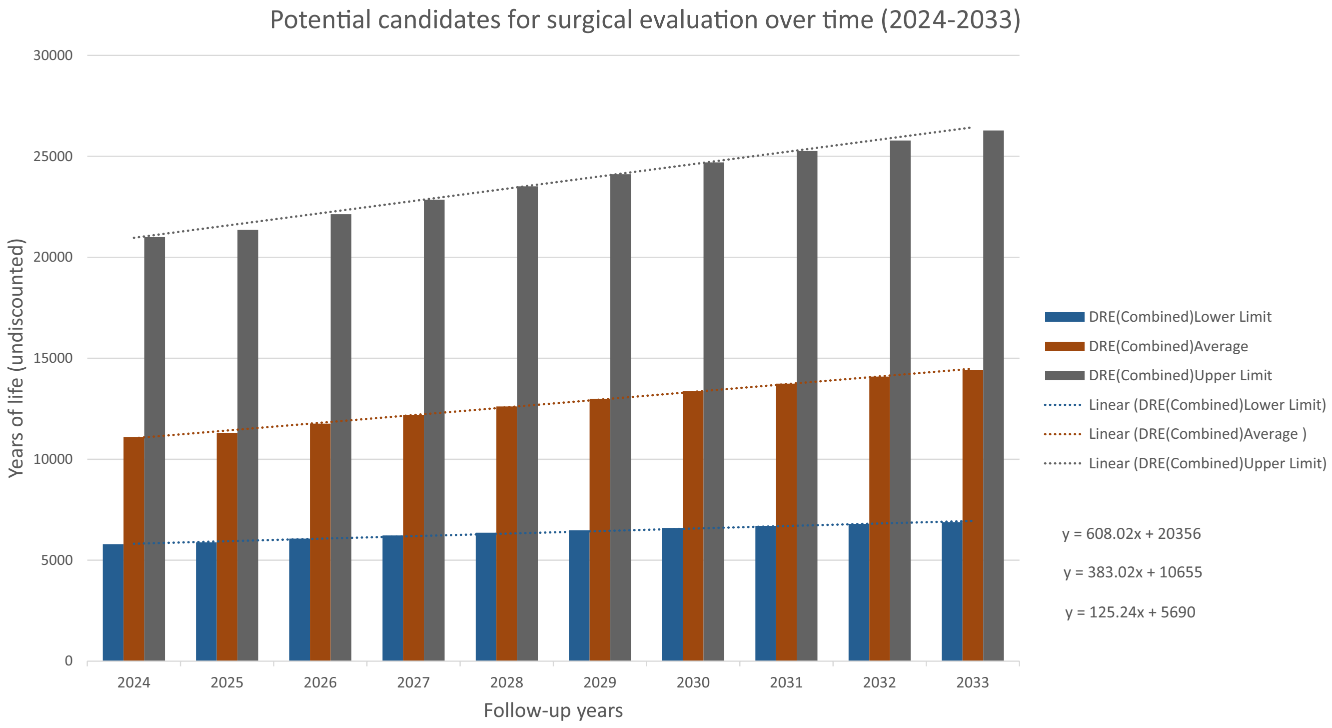

FIGURE 2 The yearly increase of people who are potential candidates for surgical management of epilepsy. DRE, drug-resistant epilepsy; x, number of years from baseline; y, number of total cases per year.

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TABLE 3 Projected loss over 10 years in the key outcomes due to the states of NSF and DRE.

Year	Cost loss	QALY loss	PALY loss
NSF			
2024	$478 530 645	9169	2236
2025	$475 345 724	9209	2148
2026	$472 670 635	9035	2086
2027	$464 896 218	8848	2023
2028	$456 106 608	8648	1960
2029	$446 327 548	8437	1897
2030	$436 416 598	8221	1835
2031	$426 167 755	7999	1775
2032	$415 496 670	7773	1716
2033	$404 613 465	7543	1657
DRE			
2024	$250 444 551	920	419
2025	$242 016 393	895	381
2026	$239 391 842	889	373
2027	$236 311 624	882	363
2028	$232 693 194	871	352
2029	$228 386 750	858	342
2030	$223 937 989	844	331
2031	$219 240 966	828	320
2032	$214 233 023	811	310
2033	$209 049 368	793	300

Abbreviations: DRE, drug-resistant epilepsy; NSF, not seizure-free; PALY, productivity-adjusted life year; QALY, quality-adjusted life year.

in drug-resistant states are likely to remain there, experiencing higher health care costs, disability, and mortality. The overall prevalent cohort is expected to be at least one and a half times larger than the new onset epilepsy cases. However, because the majority will be >10 years postdiagnosis, the anticipated changes in their health states will be lower compared to the new onset group. Capturing these trends is crucial for the early allocation of resources to comprehensive epilepsy care programs aiming to reduce the proportion of individuals without seizure freedom and reverse the trajectory of drug resistance.

The DRE state attributed to approximately one fifth of total YLs, while accounting for more than one third of the total health care costs. People with DRE often require substantial caregiver support and additional welfare assistance from government programs like the Disability Support Pension and the National Disability Insurance Scheme.[32] It is crucial to explore comprehensive care options for this group as early as possible, as our study found that having this health state is predicted to incur high costs of approximately $229 million per year. Among individuals with DRE, many with focal epilepsy are potential candidates for surgery.[39,40] The model predicted approximately 10 655 people eligible for a referral for surgical evaluation in 2024, with an additional 383 cases becoming eligible each year thereafter. Although these surgeries are effective and safe in suitable candidates, they remain underutilized for epilepsy,[41] with an average delay of 17 years from initial disease presentation.[42] This underscores the need to enhance the current facilities available for managing DRE by increasing investments in newer comprehensive epilepsy care units. The current model could be used to inform policymakers on the benefits of surgery. It can assess the impact of transitioning individuals with DRE from NSF to SF through surgery, which is associated with reduced health care expenditure. Additionally, by tracking yearly trajectories, the model can account for delays in surgery due to the implementation of comprehensive epilepsy care.

An Australian semi-Markov model[43] found that current SF status predicts seizure freedom for up to five years, with individuals clustering in SF states over time within each treatment regimen, supporting our findings on the current SOC. No other studies using a similar approach were identified for comparison with our projected estimates. The closest available study was an Australian analysis[44] that used a static prevalent cohort for epilepsy, projecting YLs, PALYs, and costs for individuals aged 15–69 years until age 70 years. This study reported 1 276 658 YLs, 25 037 deaths, 419 661 PALYs, and direct costs of $9.65 billion USD. The current model has included additional inputs such as more health states, incident cases, informal health care costs, and QALY measures stratified by health states.

This model functions as an open platform, allowing other countries to adapt and customize it according to their needs. It offers the flexibility to modify inputs and test various scenarios when new interventions are introduced. The model is designed to capture changes in transition probabilities resulting from population-level interventions, enabling the assessment of the cost-effectiveness of health care programs compared to the current SOC. Dynamic models for other diseases, such as cardiovascular disease[45] and stroke,[46] have utilized similar outcomes. A 10-year Australian model estimated $44 billion in health care costs for 1 million people with cardiovascular events,[45] whereas our study predicted $14 billion for 200 000 people. Although total costs are higher for cardiovascular disease due to its prevalence, epilepsy is significantly costlier per person.

Epilepsy imposes an additional psychological burden on individuals, making it crucial to define when epilepsy is considered resolved. Since 2014, the International League Against Epilepsy has defined it as SF state for the last 10 years,[38] with the goal of alleviating the burden of being labeled with a diagnosis of epilepsy. Our model has

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incorporated this definition as a sensitivity analysis to examine the impact of seizure resolution.

4.1 | Strengths

We developed a model using the best available evidence projecting the current SOC for epilepsy. This enables policymakers to evaluate new projects by examining expected user numbers, financial implications, and return on investment over time. The model considered seizure resolution, which could influence projections. By utilizing a clinical cohort study to assess health state transitions, the model effectively captured the yearly progression and transitions to seizure freedom within both NDRE and DRE groups. Although previous studies have developed economic models for epilepsy, this model uniquely integrates key outcome measures with a societal perspective.

4.2 | Limitations

A significant limitation was the lack of data from a prevalent cohort under follow-up, which we addressed by creating a virtual cohort. Some conservative inputs were derived from non-Australian populations. Notably, the use of transition probabilities from Glasgow assumes that treatment options and outcomes SOC are similar in Australia. The most commonly dispensed antiseizure medications in Australia are comparable to those used in the Glasgow cohort,[4] and this was the only available study to derive robust transition probabilities.[20,43] Additionally, studies suggest that the introduction of newer antiseizure medications has not significantly altered the rate of seizure control, thereby supporting the validity of our assumptions.[47,48] This model does not directly assess the efficacy or frequency of surgical interventions for drug-resistant focal epilepsy due to the absence of surgery-related data in the Glasgow cohort. Due to the lack of evidence, some assumptions have to be made for inputs, which may not reflect the true burden of epilepsy in the real world. For example, we assumed that those who are SF will have the same level of absenteeism as that of general population.

5 | CONCLUSIONS

We developed a dynamic life table model to quantify the decade-long impact of current epilepsy care in Australia. The model demonstrates the future quality of life impact, productivity loss, and cost burden due to uncontrolled seizures and drug resistance, reinforcing the need for further investment in epilepsy care. Individuals with DRE are expected to bear a higher share of societal costs, and the current number of people screened for surgical evaluation annually is insufficient. This model will support the planning of comprehensive epilepsy care programs and aid in budget impact analysis.

AUTHOR CONTRIBUTIONS

Gopisankar Mohanannair Geethadevi: Concept and design; analysis and interpretation of data; drafting of manuscript; statistical analysis. **Kristoffer Jarlov Jensen:** Concept and design; analysis and interpretation of data; critical revision of the paper; statistical analysis; supervision. **Patrick Kwan:** Acquisition of data; interpretation of results; critical revision of the paper. **Emma Foster:** Concept and design; acquisition of data; critical revision of the paper. **Graeme Jackson:** Concept and design; analysis and interpretation of data; critical revision of the paper; provision of study material; obtaining funding; administrative, technical, or logistic support; supervision. **Zhibin Chen:** Concept and design; acquisition; analysis and interpretation of data; critical revision of the paper. **Zanfina Ademi:** Concept and design; analysis and interpretation of data; critical revision of the paper; provision of study material; obtaining funding; administrative, technical, or logistic support; supervision.

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CONFLICT OF INTEREST STATEMENT

G.M.G. has no conflicts of interests to disclose. E.F. has no conflicts of interests to disclosure relevant to this work. E.F. or her institution has received research support from the Brain Foundation (Australia), GPCE, LivaNova (USA),

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Lundbeck (Australia), Monash Partners STAR Clinician Fellowship, Sylvia and Charles Viertel Charitable Foundation, and Royal Australasian College of Physicians Fellows Research Establishment Fellowship. Z.C. has no conflicts of interests to disclosure relevant to this work. Z.C. or his institution has received research support from UCB Pharma. K.J.J. has no conflicts of interest to disclose. P.K. has no conflicts of interests to disclosure relevant to this work. G.J. has no conflicts of interests to disclosure relevant to this work. Z.A. has no conflicts of interest to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

DATA AVAILABILITY STATEMENT

Most of the study input is from previously published articles. Upon formal request and ethics approval, deidentified data from the AEP may be shared with authorized researchers on request.

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APPENDIX A

A.1 | AUSTRALIAN EPILEPSY PROJECT INVESTIGATORS

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