Microsimulation Model to Estimate the Clinical and Cost Burden of Adverse Events Related to Long-Term Oral Corticosteroid Usage in Autoimmune Diseases in the United States

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BACKGROUND

Quantifying the Adverse Event Burden Associated with Oral Corticosteroid Treatment

- Oral corticosteroids (OCS) are often prescribed for prolonged durations to manage autoimmune conditions but are associated with clinically significant adverse events (AEs).
- Despite the frequency of OCS-associated AEs, rigorous studies of the clinical and economic burdens of extended OCS use are sparse.
- A model was developed to quantify lifetime clinical and economic burdens of AEs related to prolonged high-dose OCS use, relative to a hypothetical steroid-sparing treatment, across four autoimmune diseases: myasthenia gravis (MG), chronic inflammatory demyelinating polyneuropathy (CIDP), immune thrombocytopenia (ITP), and lupus nephritis (LN).
- Detailed findings are reported for patients with MG.

MODEL STRUCTURE

- A long-term standard OCS regimen was compared with a steroid-sparing regimens of 50% of standard dose in the base case. Inputs for sex, age, and dose distributions were sourced from literature (**Figure 1**).
- The model incorporated costs, disutilities, and mortality associated with 13 long- and short-term OCS-related AEs.
  - **Long-term AEs:** osteoporosis, cardiovascular disease (CVD), diabetes, depression, glaucoma, adrenal insufficiency
  - **Short-term AEs:** pneumonia, avascular necrosis, fractures, delirium, cataracts, peptic ulcers, urinary tract infections
- Per-cycle risk of patients developing each AE depended on current or cumulative dose, assuming a 5-year dose accumulation window.

INPUTS & KEY ASSUMPTIONS

- **Patients:** A simulated patient cohort was created with a distribution of age and sex based on typical patients with MG.[1-2]
- **Dosing:** Patients initiated at the maximum OCS dose (75mg) for a 3-month cycle, then received an MG-specific ongoing dose.[3]
- **AEs:** Patients could enter the model with prevalent long-term AEs at baseline. Risk of AE incidence by OCS dose was defined by published hazard ratios (HRs).[4-9] Median duration for most prevalent AEs was assumed to be 20 years based on clinical input.
- **Costs:** Inflated to 2024 United States (US) dollars. Short-term AE management cost was applied once annually. Long-term AE costs were applied per cycle spent with the AE. [7]
- **Disutility:** AE-related disutilities were assumed to be additive.[10] MG-related disutility was 0.137.[11]
- **Mortality:** AE-specific and MG-related HRs for mortality were applied.[12-17]
- **Sensitivity Analysis:** Model inputs were varied by 95% CI, if available, or by +/-20%.

RESULTS

Base Case

- The simulated cohort of patients with MG (N=3,000) was 55.4 years old (standard deviation [SD]: 13.7) on average and 54% male, receiving an average daily maintenance dose of 15.9 mg (SD: 11.1) prednisone equivalent.
- A 50% reduction in OCS dose across the base case (BC) cohort yielded gains of 0.32 life years (LYs) and 0.56 quality-adjusted life years (QALYs), and reduced lifetime AE management costs by $24,915 (95% confidence interval [CI]: $22,571 – $27,313) (**Table 1, Figure 2**).

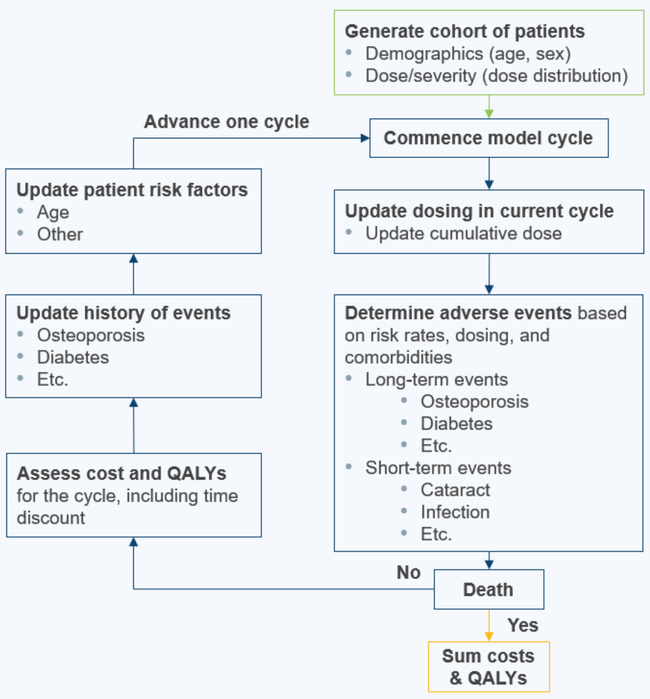
One-Way Sensitivity Analysis

- Based on one-way sensitivity adjustment (**Figure 3**), model inputs with the greatest impact on AE management cost differences between dosage groups were:
  1. AE incidence HRs by OCS dose
  2. Mean patient cohort age
  3. AE-related mortality HRs
- Longer lifetimes from lower age or mortality risk raised the cost impact of OCS-related AEs.

Scenario Analysis

- Younger and female-only cohorts had greater incremental QALYs and greater cost savings for the 50% steroid-sparing arm (**Table 2**). The higher impact of OCS-related AEs was driven by longer exposure time, given longer remaining lifetime of these populations.
- Doubling the prevalence of baseline comorbidities reduced LYs and increased AE management costs (data not shown).
- The largest cost and QALY differences were observed when the cumulative dose window setting was increased to 10 years for both arms, or when the minimum ongoing dose was increased to 20mg for both arms.
- QALY gains were highest when comparing scenarios of full-dose OCS vs. no OCS, with cost savings of $41,368 and incremental QALY gain of 1.41. Limiting OCS use to 6 months resulted in cost savings of $38,479 per patient and incremental QALY gain of 1.24.
- Similar or greater OCS-sparing benefits were observed using disease-specific demographic and dosing inputs for the 3 other autoimmune conditions (data on file).

FIGURE 1 Model Structure



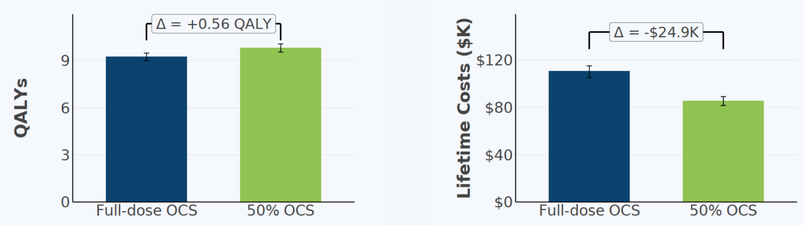
Abbreviation: QALY, quality-adjusted life year.

TABLE 1 OCS-Sparing is Associated with LY and QALY Gains and Lifetime Cost Savings

	Full-dose OCS	50% OCS	Difference
LYs (95% CI)	15.40 (14.98 – 15.82)	15.72 (15.30 – 16.15)	+0.32 (+0.42 – +0.24)
QALYs (95% CI)	9.23 (8.99 – 9.48)	9.80 (9.54 – 10.06)	+0.56 (+0.62 – +0.51)
Costs (95% CI)	$110,514 ($105,416 – $115,201)	$85,598 ($81,650 – $89,136)	-$24,915 (-$22,571 – -$27,313)

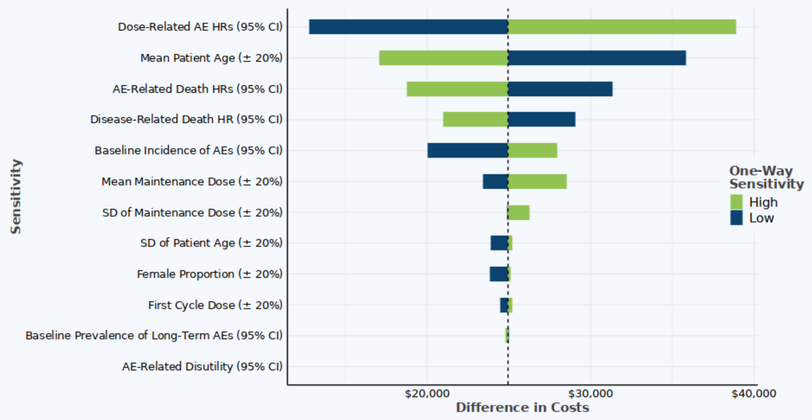
Abbreviations: CI, confidence interval; LY, life year; OCS, oral corticosteroids; QALY, quality-adjusted life year.

FIGURE 2 OCS-Sparing is Associated with Increased QALYs and Lower Costs



Note: Error bars represent bootstrapped 95% CI.
Abbreviations: CI, confidence interval; OCS, oral corticosteroids; QALY, quality-adjusted life year.

FIGURE 3 Difference in Costs Following One-Way Sensitivity Adjustment



Abbreviations: AE, adverse event; CI, confidence interval; HR, hazard ratio; SD, standard deviation.

TABLE 2 Scenario Analysis – QALY and Lifetime Costs

Category	Setting	QALY Gains	Cost Savings
Base case (BC)	–	+0.56	-$24,915
Scenarios			
Population demographic (BC: all-comers)	Age 18-64	+0.71	-$29,866
	Female < 55	+0.90	-$39,496
Cumulative dose window (BC: 5 years)	3 years	+0.48	-$14,090
	10 years	+0.78	-$54,504
Dose range (BC: 5mg+)	10mg+	+0.68	-$31,006
	20mg+	+0.91	-$53,368
Steroid-sparing approach (BC: 50% OCS)	No OCS	+1.41	-$41,368
	OCS first 6 months only	+1.24	-$38,479

Abbreviations: BC, base case; mg, milligram; OCS, oral corticosteroids; QALY, quality-adjusted life year.

KEY TAKEAWAYS

Clinically-equivalent treatment **strategies that reduce OCS use** are projected to **meaningfully increase life years and quality of life,** and to **reduce AE-related economic burden,** in patients with MG and other autoimmune conditions.

Level and duration of OCS dose, and patient **age at disease onset** are all key determinants of **clinical and economic burdens** of treatment-related AEs.

CONCLUSIONS

- **Results from the model illustrate that a 50% reduction in OCS exposure could lead to large savings on AE-related costs while meaningfully reducing mortality and morbidity.**
- **Sensitivity analyses indicated that higher initial OCS doses and longer patient lifetimes amplified cost and QALY benefits for the steroid-sparing strategy, showing that younger patients also have a large clinical and economic benefit from steroid-sparing practices.**
- **Even greater benefits were observed when evaluating full-dose OCS against alternative steroid-sparing approaches with greater reductions in OCS exposure (i.e., vs. no OCS, vs. OCS use limited to 6 months).**
- **These findings, along with consistent results in three other autoimmune conditions, highlight steroid-sparing as a valuable element of autoimmune condition management, and support the need to develop treatment strategies that reduce exposure to high-dose long-term OCS.**

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REFERENCES

1. Basoff D, Parthan A, Bandaru R, Thanataveerat A, Kent M, Habib AA. Poster presented at: AAN 2023 Annual Meeting; April 22–27, 2023; Boston, MA, USA.
2. Harris L, Graham S, MacLachlan S, Exuzides A, Jacob S. *BMC Neurol.* 2022;22:172.
3. Lee I, Kaminski HJ, McPherson T, Feese M, Cutter G. *Neurol Neuroimmunol Neuroinflamm.* 2018;5(6):e507.
4. Broder MS, Sarsour K, Chang E, et al. *Semin Arthritis Rheum.* 2016;46(2):246-52.
5. Gibson D, Branscombe N, Martin N, et al. *Pharmacoecon Open.* 2024;8(6):923-34.
6. Broersen LHA, Pereira AM, Jørgensen JO, Dekkers OM. *J Clin Endocrinol Metab.* 2015;100(6):2171-80.
7. Best JH, Kong AM, Lenhart M, Sarsour K, Stott-Miller M, Hwang Y. *J Rheumatol.* 2018;45(3):320-8.
8. Shah M, Chaudhari S, McLaughlin TP, Kan HJ, Bechtel B, Dennis GJ, Molta CT. *Clin Ther.* 2013;35(4):486-97.
9. Fardet L, Petersen I, Nazareth I. *Am J Psychiatry.* 2012;169(5):491-7.
10. Sullivan PW, Slejko JF, Sculpher MJ, Ghushchyan V. *Med Decis Making.* 2011;31(6):800-4.
11. Dewilde S, Kousoulakou H, Janssen M, et al. *Value Health.* 2022;25(1, Suppl):S246.
12. Taylor KS, Heneghan CJ, Farmer AJ, et al. *Diabetes Care.* 2013;36(8):2366-71.
13. Cai S, Fan J, Zhu L, et al. *Bone.* 2020;141:115597.
14. Mebrahtu TF, Morgan AW, Keeley A, Baxter PD, Stewart PM, Pujades-Rodriguez M. *J Clin Endocrinol Metab*. 2019;104(9):3757-67.
15. Li W, Chen D, Ruan W, Peng Y, Lu Z, Wang D. *J Affect Disord.* 2022;298(Pt A):134-41.
16. Hippisley-Cox J, Coupland C. *BMJ.* 2017;358:j4208.
17. Liu Y, Huang C, Lin R, et al. 2024. doi:10.2139/ssrn.4787477. [Pre-print]

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