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Adverse Clinical Outcomes and Economic Burden of Corticosteroid Use in IgAN: A US Real-World Study

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Introduction

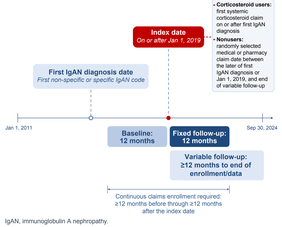
- Immunoglobulin A nephropathy (IgAN) can lead to progressive kidney function decline and kidney failure, resulting in substantial long-term disease burden[1,2]
- For patients at risk of progressive loss of kidney function, systemic corticosteroid therapy may delay the decline in glomerular filtration rate.[3] The associated risks of systemic corticosteroids are well known, with elevated rates of adverse events (e.g., infections, osteoporosis, hypertension, diabetes) well-documented for IgAN patients specifically[4–7]
- Whereas the clinical risks of systemic corticosteroids in IgAN are established, the real-world health-economic burden associated with their use is less well characterized. The introduction of a diagnostic code specific to IgAN in the International Classification of Diseases, Tenth Revision (ICD-10), in October 2023 has made claims-based analyses of this burden more feasible[8]
- Accordingly, we performed a claims-based study to better understand the clinical and economic burden associated with systemic corticosteroid use, including adverse clinical outcomes, healthcare resource utilization (HCRU), and healthcare costs among IgAN patients in the United States

Methods

Design

- Retrospective observational cohort study using data from the Merative MarketScan® Research Databases
  - The data source provides integrated administrative healthcare claims information on more than 42 million insured across the United States, offering an extensive dataset for health-economic analyses
- Adults with primary IgAN who were treated with or without systemic corticosteroids were identified and compared for outcomes of interest during follow-up (**Figure 1**)

Figure 1. Study Design



IgAN, immunoglobulin A nephropathy.

Cohort Eligibility

Key Inclusion Criteria	Key Exclusion Criteria
• IgAN diagnosis by specific ICD-10 code (N02.8X)[1]	• Secondary IgAN diagnosis
• Index date on or after January 1, 2019	• Dialysis, kidney transplant, or end-stage kidney disease
• Age ≥18 years at index	• Malignancy
• Continuous claims enrollment ≥12 months before index (baseline period) and ≥12 months after index (fixed follow-up period)	• Any use of corticosteroids during the baseline period
Additional Criteria for Corticosteroid Users	
• ≥1 claim for a systemic corticosteroid on or after the first IgAN diagnosis date	
• Date of the first corticosteroid claim on or after diagnosis served as the patient's index date	
Additional Criteria for Corticosteroid Nonusers	
• No claims for any corticosteroids (targeted-release budesonide was also excluded to avoid exposure misclassification)	
• A medical or pharmacy claim date was randomly selected as the patient's index date	

[1]If an earlier, non-specific code indicative of IgAN was identified, the earlier date was considered the time of first IgAN diagnosis.

Standardized Mortality Ratio (SMR) Weighting

- To control for potential confounding and improve comparability between corticosteroid users and nonusers, SMR weighting was applied
- SMR reweighted the nonuser cohort so that its baseline covariate distribution mirrored that of corticosteroid users
- Weights were estimated from propensity score models that incorporated potentially confounding variables, which were identified based on clinical and statistical relevance, targeted literature review, and clinical opinion:
  - Age
  - Sex
  - Diabetes
  - Infections
  - CKD stage
  - RASi use
  - Quan-Charlson Comorbidity Index score
  - Hypertension
  - SGLT2i use

CKD, chronic kidney disease; RASi, renin-angiotensin system inhibitor; SGLT2i, sodium-glucose cotransporter-2 inhibitor.

- The balance of baseline characteristics between corticosteroid users and SMR-weighted nonusers was assessed using standardized mean differences, with values <0.10 indicating adequate balance
- Covariates included in the propensity score model that remained imbalanced after weighting were additionally adjusted for in the outcome regression models

Outcomes

- Corticosteroid exposure. Average daily dose was calculated by converting various forms of systemic corticosteroids (both oral and injectable formulations) to prednisone-equivalent dosages
- Incidences of and time to adverse clinical outcomes of interest: bone-related complications, diabetes/ hyperglycemia, dyslipidemia, gastrointestinal bleeding, hypertension, neuropsychiatric events, infections
  - Incident and worsening hypertension were captured, with the latter identified by a diagnosis code for hypertensive urgency with evidence of treatment intensification
  - Non-serious and serious infections were captured, with the latter identified from diagnoses associated with an inpatient or emergency department medical claim
- HCRU: inpatient, outpatient, emergency department, and other visits
- Healthcare costs (2025 US dollars): expenditures for inpatient, outpatient, emergency department, and other visits; pharmacy costs
- Outcomes were assessed over the 12-month follow-up after the index date
  - Time to adverse clinical outcomes was additionally followed to the end of variable follow-up

Comparative Analyses

- Risk differences (RD) between corticosteroid users and nonusers for adverse clinical outcomes were estimated using SMR-weighted linear probability models with robust standard errors
- Time to adverse clinical outcomes was estimated using weighted Kaplan–Meier methods and SMR-weighted Cox regression models
- Mean differences in HCRU and costs were estimated with 95% confidence intervals (CI) derived via bootstrap methods

KEY POINTS

Study Design
Retrospective claims-based study in IgAN comparing 171 systemic corticosteroid users with 120 nonusers; nonusers were SMR weighted to resemble corticosteroid users at baseline (weighted n = 168)

Findings
Systemic corticosteroid use was associated with a significantly higher proportion of adverse clinical outcomes (57.3% of patients) vs nonuse (42.8%; P=0.04) over 12-month follow-up

Healthcare resource utilization and healthcare costs were substantially greater for systemic corticosteroid users (mean annual healthcare cost of $28,284 vs $3,764; P<0.001)

Clinical Relevance
Systemic corticosteroid use in IgAN was associated with substantial clinical and economic burden, highlighting the importance of treatment strategies that reduce corticosteroid-associated risks and healthcare burden

Results

Cohort Characteristics

- Of 2,511 patients with IgAN in the database, 171 systemic corticosteroid users and 120 nonusers met the cohort eligibility criteria
- After SMR weighting, the weighted sample size was 168 in the nonuser cohort
- Baseline characteristics included in the propensity score model were generally well balanced after weighting (**Table 1**)
  - About half of patients had CKD at baseline (54.4% of corticosteroid users vs 54.8% of SMR-weighted nonusers), with comparable stage distribution
  - Mean (standard deviation [SD]) Quan-Charlson Comorbidity Index score was 0.8 (0.8) vs 0.8 (0.7), and almost two-thirds had hypertension (64.3% vs 66.2%)
  - Approximately three-quarters of patients received RASi therapy at baseline (75.4% vs 76.5%)
- Remaining imbalanced model covariates were additionally adjusted for in outcome regression models
- Mean (SD) time from diagnosis to index date was 25.8 (28.5) months in corticosteroid users and 28.5 (27.5) months in SMR-weighted nonusers

Table 1. Baseline Characteristics After SMR Weighting

	Corticosteroid Users (n = 171)	SMR-Weighted Nonusers[1] (n = 168)	SMD[2]
Age at index in years, mean ± SD [median]	44.7 ± 12.1 [46.0]	45.2 ± 12.6 [45.0]	0.04
Male sex, n (%)	96 (56.1%)	96 (57.1%)	0.02
Geographic region at index, n (%)			
South	55 (32.2%)	60 (35.5%)	0.07
Midwest	42 (24.6%)	38 (22.8%)	0.04
West	38 (22.2%)	37 (21.8%)	0.01
Northeast	36 (21.1%)	33 (19.9%)	0.03
Medical insurance type at index, n (%)			
PPO	94 (55.0%)	85 (50.4%)	0.09
HDHP	34 (19.9%)	27 (16.1%)	0.10*
CDHP	19 (11.1%)	14 (8.4%)	0.09
Other[3]	24 (14.0%)	42 (25.1%)	0.28*
Months from diagnosis to index date, mean ± SD [median]	25.8 ± 28.5 [15.1]	28.5 ± 27.5 [18.6]	0.09
CKD, n (%)			
Patients with documented CKD stage	93 (54.4%)	92 (54.8%)	0.01
Stage G1	8 (4.7%)	7 (4.1%)	0.03
Stage G2	16 (9.4%)	19 (11.2%)	0.06
Stage G3	55 (32.2%)	54 (32.2%)	0
Stage G4	12 (7.0%)	12 (7.3%)	0.01
Stage G5	2 (1.2%)	0 (0.0%)	0.15*
Quan-Charlson Comorbidity Index score, mean ± SD [median]	0.8 ± 0.8 [1.0]	0.8 ± 0.7 [1.0]	0.01
Individual comorbidities, n (%)			
Hypertension	110 (64.3%)	111 (66.2%)	0.04
Anemia in CKD	15 (8.8%)	11 (6.5%)	0.09
Chronic pulmonary disease	14 (8.2%)	15 (9.2%)	0.04
Nephrotic syndrome	14 (8.2%)	3 (1.8%)	0.3*
Diabetes mellitus	13 (7.6%)	17 (10.4%)	0.10*
Hyperkalemia	11 (6.4%)	6 (3.3%)	0.14*
Adverse clinical outcomes during the baseline period, n (%)			
Infections	71 (41.5%)	68 (40.7%)	0.02
Dyslipidemia	74 (43.3%)	82 (48.9%)	0.11*
Neuropsychiatric events	33 (19.3%)	25 (14.8%)	0.12*
Hyperglycemia	12 (7.0%)	16 (9.8%)	0.10*
Gastrointestinal bleeding	7 (4.1%)	5 (3.1%)	0.05
Bone-related complications	5 (2.9%)	5 (2.9%)	0
Diabetic ketoacidosis	0 (0.0%)	0 (0.0%)	0
Hyperosmolar hyperglycemic state	0 (0.0%)	0 (0.0%)	0
IgAN-related treatment during the baseline period, n (%)			
RASi	129 (75.4%)	128 (76.5%)	0.02
ACEi	76 (44.4%)	78 (46.3%)	0.04
ARB	61 (35.7%)	59 (35.5%)	0
SGLT2i	9 (5.3%)	9 (5.2%)	0

[1]Other medical insurance type included basic/major medical, comprehensive, EPO, and non-capitated POS. [2]The weighted population was derived from the actual nonuser population of n = 120. The sample size for the SMR-weighted cohort reflected the sum of the weights. *An SMD <0.10 indicated adequate balance between the cohorts; SMD ≥0.10 is denoted with an asterisk.

ACEi, angiotensin-converting enzyme inhibitors; ARB, angiotensin II receptor blockers; CDHP, consumer-directed health plan; CKD, chronic kidney disease; EPO, exclusive provider organization; HDHP, high-deductible health plan; IgAN, immunoglobulin A nephropathy; POS, point of service; PPO, preferred provider organization; RASi, renin–angiotensin system inhibitors; SD, standard deviation; SGLT2i, sodium–glucose cotransporter-2 inhibitors; SMD, standardized mean difference; SMR, standardized mortality ratio.

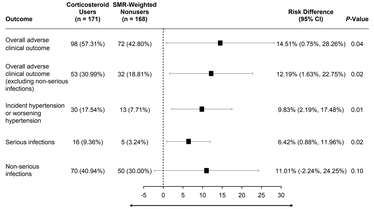
Corticosteroid Exposure

- Over 12 months, the mean (SD) cumulative duration of treatment with systemic corticosteroids was 1.4 (2.2) months
- The first course of treatment was typically brief, with a median (95% CI) time to discontinuation of 0.4 (0.2, 0.5) months
- Some patients received multiple courses of corticosteroids; the mean (SD) number of treatment periods was 1.5 (0.7)
- The corticosteroids used at index were prednisone/prednisolone (47.4%), methylprednisolone (33.9%), dexamethasone (23.4%), and hydrocortisone (0.6%) – 9 individuals were taking >1 type of corticosteroid at index
- The mean (SD) daily corticosteroid dose during follow-up was 37.2 (97.1) mg/day; the median (interquartile range) was 21.1 (12.9, 40.0) mg/day

Adverse Clinical Outcomes

- Over 12-month follow-up, 57.3% of systemic corticosteroid users experienced ≥1 adverse clinical outcome versus 42.8% of SMR-weighted nonusers (RD 14.5%, 95% CI 0.8%–28.3%, P=0.04) (**Figure 2**)
- Excluding non-serious infections, the proportion of patients with ≥1 adverse clinical outcome remained higher among corticosteroid users (RD 12.2%, 95% CI 1.6%–22.8%, P=0.02)
- The proportion of patients with incident or worsening hypertension (RD 9.8%, 95% CI 2.2%–17.5%, P=0.01) or serious infections (RD 6.4%, 95% CI 0.9%–12.0%, P=0.02) was significantly higher among corticosteroid users

Figure 2. Incidence of Adverse Clinical Outcomes Over 12 Months



Outcomes with few occurrences across cohorts are not shown. Risk differences were estimated using an SMR-weighted linear probability model with 95% CI estimated using robust standard errors. For the serious and non-serious infection outcomes, diabetes at baseline remained imbalanced between groups after SMR weighting and was additionally included as a covariate in the outcome regression models.
CI, confidence interval; SMR, standardized mortality ratio.

- Corticosteroid users experienced their first overall adverse clinical outcome earlier than nonusers (median 7.4 vs 14.8 months; HR 1.5, 95% CI 1.2–1.9; P=0.002), as assessed during the variable follow-up period

Healthcare Resource Utilization

- Systemic corticosteroid users had higher all-cause HCRU than SMR-weighted nonusers over 12 months of follow-up (**Table 2**)
  - For example, the proportion of patients with ≥1 inpatient admission was 8.8% versus 0.9% (P<0.001); the proportion with ≥1 emergency department visit was 30.4% versus 12.2% (P<0.001)
- Similarly, the proportions of patients with inpatient, emergency department, and other visits related to adverse clinical outcomes were significantly higher for corticosteroid users

Table 2. Healthcare Resource Utilization Over 12 Months

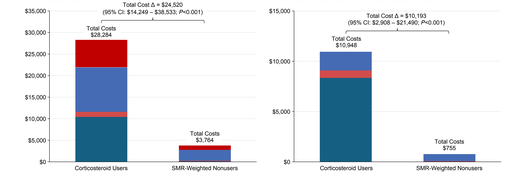
	Corticosteroid Users (n = 171)	SMR-Weighted Nonusers (n = 168)	Difference	(95% CI)[1]	P-Value[1]
All-cause HCRU					
IP admissions					
Patients with ≥1 IP admission, n (%)	15 (8.77%)	1 (0.88%)	7.89%	(3.51%, 12.30%)	<0.001
Number of IP admissions, mean ± SD	0.14 ± 0.60	0.01 ± 0.09	0.13	(0.05, 0.23)	<0.001
ED visits[1]					
Patients with ≥1 ED visit, n (%)	52 (30.41%)	20 (12.16%)	18.25%	(8.05%, 27.46%)	<0.001
Number of ED visits, mean ± SD	0.81 ± 1.29	0.17 ± 0.51	0.45	(0.23, 0.66)	<0.001
OP visits[2]					
Patients with ≥1 OP visit, n (%)	171 (100.00%)	168 (100.00%)	0.00%	(0.00%, 0.00%)	1
Number of OP visits, mean ± SD	24.71 ± 40.36	11.80 ± 9.37	12.91	(7.19, 20.16)	<0.001
Other visits[3]					
Patients with ≥1 other visit, n (%)	40 (23.39%)	21 (12.30%)	11.09%	(0.38%, 20.63%)	0.05
Number of other visits, mean ± SD	0.81 ± 2.16	0.48 ± 1.76	0.33	(-0.30, 0.85)	0.22
Adverse clinical outcome–related HCRU[4]					
IP admissions					
Patients with ≥1 IP admission, n (%)	13 (7.60%)	1 (0.32%)	7.28%	(3.50%, 11.06%)	<0.001
Number of IP admissions, mean ± SD	0.12 ± 0.56	0.00 ± 0.06	0.12	(0.05, 0.21)	<0.001
ED visits[1]					
Patients with ≥1 ED visit, n (%)	32 (18.71%)	10 (6.07%)	12.64%	(4.29%, 20.25%)	0.01
Number of ED visits, mean ± SD	0.37 ± 1.02	0.06 ± 0.26	0.31	(0.15, 0.47)	<0.001
OP visits[2]					
Patients with ≥1 OP visit, n (%)	95 (55.56%)	72 (42.80%)	12.75%	(-2.44%, 27.04%)	0.09
Number of OP visits, mean ± SD	4.99 ± 11.34	2.55 ± 4.81	2.44	(0.60, 4.56)	0.01
Other visits[3]					
Patients with ≥1 other visit, n (%)	4 (2.34%)	0 (0.00%)	2.34%	(0.57%, 4.99%)	<0.001
Number of other visits, mean ± SD	0.12 ± 0.91	0.00 ± 0.00	0.12	(0.01, 0.28)	<0.001

[1]ED visits denoted ED visits not leading to hospitalization. [2]OP visits included healthcare encounters other than hospitalizations or ED visits, and excluded durable medical equipment, dental, or vision care. [3]Other visits included durable medical equipment, dental and vision care. [4]Adverse clinical outcome-related HCRU was defined from claims with a diagnosis code for an adverse clinical outcome of interest within an IP admission, OP visit, ED visit, or other visit in any position. †95% CIs and P-values of the mean differences were derived using non-parametric bootstrapping.
CI, confidence interval; ED, emergency department; HCRU, healthcare resource utilization; IP, inpatient; OP, outpatient; SD, standard deviation.

Healthcare Costs

- Mean all-cause total healthcare costs over 12 months were significantly higher among corticosteroid users than SMR-weighted nonusers, driven by inpatient ($10,400 vs $154), outpatient ($10,275 vs $2,471), and pharmacy costs ($6,342 vs $982; all P<0.001) (**Figure 3a**)
- Adverse clinical outcome-related medical costs were also significantly higher among corticosteroid users, driven by inpatient costs ($8,335 vs $33; P<0.001) (**Figure 3b**)

Figure 3. Healthcare Costs Over 12 Months, Per Patient



†Other visits included durable medical equipment, dental and vision care. †OP visits included healthcare encounters other than hospitalizations or ED visits, and excluded durable medical equipment, dental, or vision care. †ED visits denoted ED visits not leading to hospitalization. *Adverse clinical outcome-related cost was defined from claims with a diagnosis code for an adverse clinical outcome of interest within an IP admission, OP visit, ED visit, or other visit in any position.
95% CIs and P-values of the mean differences were derived using non-parametric bootstrapping. Costs are in 2025 US dollars.
CI, confidence interval; ED, emergency department; IP, inpatient; OP, outpatient; SMR, standardized mortality ratio.

STRENGTHS AND LIMITATIONS

- This analysis used a large, contemporary claims database with a dedicated ICD-10 code for IgAN, supporting identification of patients with coded IgAN
- The use of claims data enabled a comprehensive assessment of all-cause and adverse clinical outcome-related HCRU and costs across care settings
- MarketScan data primarily represents commercially insured individuals and Medicare beneficiaries with employer-sponsored supplemental insurance. Findings may not generalize to uninsured patients or other healthcare coverage settings
- Diagnosis, procedure, and drug codes are subject to potential misclassification and underreporting
- Despite adjustment for confounding variables, residual confounding by indication (more severe disease in corticosteroid users) is still possible, because claims data do not capture important clinical factors such as proteinuria, histologic findings, or glomerular filtration rate trajectory

DISCUSSION

- Systemic corticosteroid users experienced higher 12-month incidences of adverse clinical outcomes than nonusers, most notably incident or worsening hypertension and serious infections, with earlier onset among users
- Corticosteroid users had substantially higher adverse clinical outcome-related HCRU and medical costs, which may be associated with clinical management of these events as they arise. All-cause HCRU and costs were also higher, suggesting that the burden may extend beyond adverse outcome-related care
- KDIGO recommendations reflect increasing recognition of the need to balance potential kidney benefits associated with corticosteroid use against toxicity and minimize unnecessary exposure when alternative therapies are available.[3] These findings reinforce the importance of individualized treatment selection that balances kidney benefits with treatment-related risks

CONCLUSIONS

- In this real-world cohort of adult patients with IgAN in the United States, systemic corticosteroid use was associated with greater clinical and economic burden compared with nonuse
- Corticosteroid users experienced a higher 12-month occurrence of adverse clinical outcomes, more HCRU, and higher mean healthcare costs, compared to the weighted nonusers cohort
- These findings highlight the burden associated with corticosteroid use and the importance of treatment strategies to minimize the associated risks in patients with IgAN

References

1. Floege J, Bernier-Jean A, Barratt J, Rovin B. *Kidney Int.* 2025;107(4):640-651. doi: 10.1016/j.kint.2025.01.014
2. Pitcher D, Braddon F, Hendry B, et al. *Clin J Am Soc Nephrol.* 2023;18(6):727-738. doi: 10.2215/CJN.0000000000000135
3. Kidney Disease: Improving Global Outcomes (KDIGO) IgAN and IgAV Work Group; Rovin BH, Barratt J, Cook HT, et al. *Kidney Int.* 2025;108(4S):S1-S71. doi: 10.1016/j.kint.2025.04.004
4. Lv J, Wong MG, Hladunewich MA, et al; TESTING Study Group. *JAMA.* 2022;327(19):1888-1898. doi: 10.1001/jama.2022.5368
5. Oh GJ, Waldo A, Paez-Cruz F, et al. *Kidney Int Rep.* 2019;4(11):1608-1616. doi: 10.1016/j.ekir.2019.08.019
6. Aldworth C, Perkins R, Kattlun J, et al. *Kidney Int Rep.* 2022;7(2 Suppl):S98. Abstract POS-226. doi: 10.1016/j.ekir.2022.01.245
7. Pesce G, Patel M, Gusto G, Kadambi A, Chandak A, Madison T. *Front Nephrol.* 2025;5:1574239. doi: 10.3389/fneph.2025.1574239
8. Sumanshi AP, Kim CK, Chen O, Cannizzaro NT, Sim JJ. *Clin Kidney J.* 2025;18(11):sfaf327. doi: https://doi.org/10.1093/ckj/sfaf327

Disclosures

- EXD, AC, SR, and KAB are employees of Analysis Group, Inc, which performed study analyses for Otsuka.
- BL is an employee of Otsuka.
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