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Hospital Healthcare Resource Utilization and Associated Hospital Costs of Patients With Lupus Nephritis in China: A National Administrative Claim Database Study

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ABSTRACT

Objectives: Assess hospital healthcare resource utilization (HCRU) and associated hospital costs of patients with lupus nephritis (LN) in China and compare these outcomes with a systemic lupus erythematosus (SLE) cohort (SLE with/without LN) as well as exploring the effect of end-stage kidney disease (ESKD).

Methods: This retrospective administrative claims-based analysis identified patients with SLE and SLE with LN from China using diagnosis codes and keywords. Patients with LN were subcategorized by presence of ESKD. Outcomes included all-cause and disease-specific HCRU (defined as healthcare visits including inpatient and outpatient visits) and medical costs (in 2022 US dollars).

Results: In total, 3645 patients with SLE were included, of whom 404 (11%) had LN. Among those with LN, 142 (35%) had ESKD. Median (interquartile range) all-cause healthcare visits per patient per month (PPPM) was significantly greater for patients with LN (2.08 [4.01]) vs SLE (0.92 [1.64]; $P < .0001$). Patients with LN and ESKD (3.00 [4.18]) had numerically more all-cause healthcare visits PPPM compared with LN patients without ESKD (1.50 [3.45]). Median all-cause costs PPPM were significantly greater among patients with LN ($287.46 [477.15]) vs SLE ($113.09 [267.39]; $P < .0001$) and numerically higher for patients with LN and ESKD ($466.29 [958.90]) vs LN without ESKD ($223.50 [319.56]).

Conclusions: Chinese patients with LN had greater HCRU and hospital healthcare costs compared with the general SLE cohort. This burden was higher for those with ESKD. These data highlight the substantial HCRU among patients with LN in China, especially those with ESKD, suggesting the need for early diagnosis and timely management of LN to mitigate the economic burden.

Keywords: cost of illness, end-stage kidney disease, healthcare resource utilization, lupus nephritis, medical costs, systemic lupus erythematosus.

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Introduction

Systemic lupus erythematosus (SLE) is a chronic autoimmune inflammatory disease that involves the production of autoantibodies and deposition of immune complexes with complement fixation and tissue injury.[1,2] Lupus nephritis (LN) is a severe manifestation of SLE and is among the most common forms of secondary glomerulonephritis in China.[3-5] LN is associated with increased mortality, and 10% to 20% of patients with LN develop end-stage kidney disease (ESKD) within 10 years of diagnosis, requiring dialysis or transplantation.[6,7]

The Chinese Rheumatology Association recommends that patients with SLE should initially be treated with individualized glucocorticoid regimens in combination with long-term hydroxychloroquine.[8] Immunosuppressants are subsequently recommended for patients who do not respond to these initial treatments. For patients with class III, IV, or V LN, glucocorticoids are recommended in combination with cyclophosphamide or mycophenolate mofetil as induction therapy and mycophenolate mofetil or azathioprine as maintenance therapy.[8] Calcineurin inhibitors are also recommended for patients with type V LN and high-levels of proteinuria,[8] with voclosporin being approved in 2021 by the US Food and Drug Administration (FDA) for the treatment of LN[9] but not yet approved in China. The Chinese Rheumatology Association also recommends that biologics be considered among patients who are refractory or intolerant to initial treatment.[8] Belimumab is the only biologic approved for SLE and LN by both the FDA in the USA and China's National Medical Products Administration[10,11]; anifrolumab is approved by the FDA for the treatment of SLE,[12] and telitacicept is, similarly, approved by China's National Medical Products Administration,[13] but neither are approved for the treatment of LN.

Asian populations with SLE tend to have higher rates of renal disease and poorer long-term renal outcomes compared with

Caucasian populations.[14,15] For example, LN has been shown to occur in 30% to 70% of Asian patients with SLE, whereas an observational study reported that approximately 38% of a mixed population (predominantly Caucasian) of patients with SLE had LN.[6,16,17]

A systematic literature review showed that LN is associated with substantial economic and clinical burden based on several studies conducted in North America and Europe.[18] However, there are currently few published studies detailing the economic burden of LN in mainland China. This may be due to the lack of publicly available national health insurance claims databases in China. For example, the Chinese Health Insurance Research Association (CHIRA) database is under license and strict regulations, which make its data largely inaccessible. To inform this study, an entity authorized by the CHIRA (Beijing Brainpower Pharma Consulting Co. Ltd) were permitted to analyze claims data limited to a single calendar year.

The objectives of this study were to assess the hospital healthcare resource utilization (HCRU) and associated hospital costs of patients with LN in mainland China, to compare these outcomes among patients with SLE (with or without LN), and to describe these outcomes among patients with and without ESKD.

Methods

Study Design

This was a retrospective administrative claims database analysis that utilized data from the 2017 CHIRA claims database for patients with SLE and LN (Fig. 1). CHIRA includes nationwide data sampled from cities and hospitals at different levels. In 2017, over 1.3 billion people from more than 600 cities were covered by the China public insurance scheme, with a total of 68 sampling cities covered in the CHIRA database. Cities were classified as Tier 1, 2, 3, or 4/other based on their level of economic development, with Tier 1 cities having the highest economic development, such as Beijing, Shanghai, or Guangzhou, and each subsequent tier having lower levels of economic development. Once patients were sampled in the CHIRA database, all relevant data for the 2017 calendar year were accessible. All eligible patients with SLE/LN were included in the study with no further sampling. The database includes data for all 3 types of public health insurance schemes, with these insurance schemes covering over 95% of individuals in China.[19]

The study period ran from January 1, 2017, until December 31, 2017. The index date was the date of the first claim with a diagnosis of SLE and/or LN, and patients were followed up (for a maximum of 1 year) from the index date until death or the end of the study period (December 31, 2017). There were no missing data for included patients, even if patients switched between public insurance schemes.

Because this was a noninterventional study based on a secondary claim database with deidentified patient data, Ethics Committee or Institutional Review Board approval was not required. The study complied with all applicable laws regarding subject privacy. No direct subject contact or primary collection of individual human subject data occurred. All data analyses were performed by Beijing Brainpower Pharma Consulting Co. Ltd (authorized by CHIRA), and GSK (China) had no access to the database or any individual patient data.

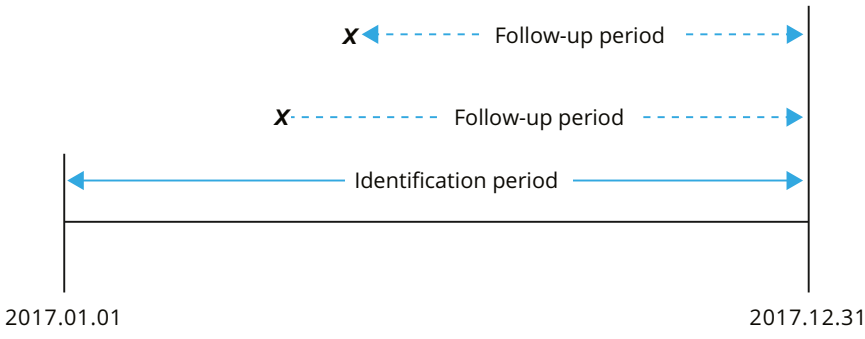
Study Population

Patients with SLE were identified based on the presence of a claim with an International Classification of Diseases 10th revision (ICD-10) code for SLE or the keywords "systemic lupus erythematosus" or "lupus" in the patient's primary or secondary diagnosis (see Appendix Methods and Appendix Table 1 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2024.101001). Patients with LN were identified from the SLE population based on the presence of a claim with an ICD-10 code for nephritis or the keywords "lupus nephritis" or "nephritis" in the patient's primary or secondary diagnosis (see Appendix Methods and Appendix Table 2 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2024.101001). Patients with ESKD were identified from the population of patients with LN based on the presence of a claim with an ICD-10 diagnosis code for ESKD (N18.6); or the keywords "ESRD," "ESKD," "Renal failure," or "Kidney failure," in the patient's primary or secondary diagnosis; or dialysis or a kidney transplant during 2017. Patient characteristics data that were collected included age, gender, insurance type, location (city tier), hospital level in attendance, recorded healthcare visits, and comorbidities.

Outcomes

All-cause and disease-specific HCRU (defined as healthcare visits and admissions, including inpatient and outpatient visits) and hospital costs (defined as costs per healthcare visit, including either outpatient visits or inpatient admissions and drug and nondrug costs) were assessed in the general SLE and SLE with LN cohorts. In the SLE with LN cohort, subgroup analyses were conducted, with groups assigned based on the presence and absence of ESKD. Disease-specific data include claims specifically coded for

Figure 1. Study design.



X = index date for each patient (first claim associated with SLE and/or LN)

LN indicates lupus nephritis; SLE, systemic lupus erythematosus.

SLE and/or LN, based on the presence of ICD-10 diagnosis codes and keywords on the medical claim. HCRU outcomes included number of healthcare visits (outpatient or inpatient) per patient per month (PPPM), number of outpatient visits PPPM, number of inpatient admissions PPPM, and mean length of stay (LoS) PPPM. Medical costs included outpatient, inpatient, drug, and nondrug costs PPPM and were measured in 2017 Chinese Yuan (CNY) and converted to 2022 US dollars (USD, $) at a cumulative consumer price index of 1.108 and an exchange rate of 1 CNY to $0.1483.[20,21] Original 2017 CNY cost data are available in the Supplemental Materials found at https://doi.org/10.1016/j.vhri.2024.101001.

Statistical Analysis

A sample size of approximately 400 unique LN patients from the SLE dataset was sufficient to provide adequate precision for the estimates in the current study, providing a margin of error of 4.9%. This calculation was based on the normal approximation to the binomial distribution.

The null hypothesis (H_0) and the alternative hypothesis (H_a) are listed as below. The significance level was set as 5% and the 2-sided *P* value was based on the standardized test statistic z, which had an asymptotic standard normal distribution under the null hypothesis.[22]

H_0: Median $_{\text{General SLE cohort}}$ = Median $_{\text{LN cohort}}$

H_a: Median $_{\text{General SLE cohort}} \neq$ Median $_{\text{LN cohort}}$

Summary statistics such as mean (standard deviation [SD]) and median (interquartile range [IQR]) values were calculated for continuous variables; and counts and proportions for categorical variables. Comparisons between the SLE cohort and LN cohort were performed with the Mann–Whitney–Wilcoxon test because the data for each were positively skewed. The level of significance was set at $P < .05$. All analyses were conducted using the SAS 9.4 statistical package (SAS Institute Inc.).

Results

Patient Population

Among a population of 3645 patients with SLE, 404 (11%) patients with a diagnosis of LN were identified from the 2017 CHIRA claims database. Among those with LN, the mean (SD) age was 45.0 (16.3) years, 335 (83%) were female, and 142 (35%) had ESKD. Characteristics of patients with LN, and patients with LN with and without ESKD are shown in Table 1. Characteristics of patients with SLE (with or without LN) are shown in Appendix Table 3 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2024.101001.

HCRU

The median (IQR) number of all-cause healthcare visits (including both inpatient and outpatient visits) PPPM for patients with LN was significantly higher than patients with SLE (2.08 [4.01] vs 0.92 [1.64], $P < .0001$; Table 2). The LN cohort also had significantly more median outpatient visits PPPM for patients with ≥1 outpatient visit compared with the SLE cohort (2.68 [4.08] vs 1.00 [1.79], $P < .0001$), and more inpatient admissions PPPM for patients with ≥1 admission (0.25 [0.40] vs 0.20 [0.26], $P = .0217$; Table 2).

Table 1. Characteristics among patients with SLE with a diagnosis of LN, LN patients with ESKD, and LN patients without ESKD.

Patient characteristics	LN patients (*N* = 404)	LN patients with ESKD (*n* = 142)	LN patients without ESKD (*n* = 262)
Total number of healthcare visits,* *n*	6041	2770	3271
Age (years), mean (SD)	45.02 (16.31)	51.41 (16.75)	41.56 (15.01)
<18 years of age, *n* (%)	11 (2.72)	1 (0.70)	10 (3.82)
Female, *n* (%)	335 (82.92)	106 (74.65)	229 (87.40)
Insurance type, *n* (%)			
URBMI (including NRCMI)	98 (24.25)	28 (19.72)	70 (26.72)
UEBMI	306 (75.74)	114 (80.28)	192 (73.28)
Tier of cities,† *n* (%)			
Tier 1	83 (20.54)	21 (14.79)	62 (23.66)
Tier 2	82 (20.29)	28 (19.72)	54 (20.61)
Tier 3	132 (32.67)	59 (41.55)	73 (27.86)
Others	107 (26.48)	34 (23.94)	73 (27.86)
Population distribution by hospital level,‡ *n* (%)			
Ever visited tertiary hospitals	347 (85.89)	128 (90.14)	219 (83.59)
Ever visited other hospitals	146 (36.14)	52 (36.92)	94 (35.88)
Healthcare visits by hospital level, *n* (%)			
Tertiary hospitals	4288 (70.98)	1946 (70.25)	2342 (71.60)
Other hospitals	1753 (29.02)	824 (29.75)	929 (28.40)
Length of follow-up (inpatient and outpatient), months, mean (SD)	10.25 (2.79)	10.53 (2.51)	10.09 (2.92)

ESKD indicates end-stage kidney disease; LN, lupus nephritis; NRCMI, New Rural Cooperative Medical Insurance; SD, standard deviation; SLE, systemic lupus erythematosus; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance.

*Inpatient or outpatient visit.

†Cities were classified into tiers (1–4) according to the economic development level, with Tier 1 cities having the highest economic development (eg, Beijing, Shanghai, and Guangzhou) and subsequent tiers having lower levels of economic development.

‡Visits to different levels of hospitals were not mutually exclusive; therefore, the sum proportion for these data can exceed 100%.

Table 2. HCRU for patients with SLE and patients with LN.

HCRU	General SLE cohort (*N* = 3645)			LN cohort (*n* = 404)			*P* value†
	*n**	Mean (SD)	Median (IQR)	*n**	Mean (SD)	Median (IQR)	
All-cause HCRU							
Number of all-cause healthcare visits PPPM							
Total‡	3797	1.76 (2.52)	0.92 (1.64)	404	3.46 (4.28)	2.08 (4.01)	<.0001
Outpatient§	3216	1.89 (2.62)	1.00 (1.79)	336	3.85 (4.41)	2.68 (4.08)	<.0001
Inpatient**	1953	0.31 (0.34)	0.20 (0.26)	278	0.38 (0.43)	0.25 (0.40)	.0217
LoS, inpatient admission, days PPPM	1953	2.53 (3.34)	1.50 (2.25)	278	3.16 (3.99)	1.89 (3.17)	.0016
Disease-specific HCRU							
Number of disease-specific healthcare visits PPPM							
Total‡	3797	0.67 (0.99)	0.33 (0.77)	404	1.37 (1.85)	0.75 (1.35)	<.0001
Outpatient§	2761	0.77 (1.04)	0.42 (0.83)	308	1.51 (1.91)	0.92 (1.58)	<.0001
Inpatient**	1597	0.27 (0.30)	0.17 (0.24)	245	0.36 (0.41)	0.25 (0.35)	<.0001
LoS, inpatient admission, days PPPM	1597	2.20 (3.26)	1.20 (1.86)	245	3.03 (4.01)	1.67 (2.82)	<.0001

HCRU indicates healthcare resource utilization; IQR, interquartile range; LN, lupus nephritis; LoS, length of stay; PPPM, per patient per month; N, number; SD, standard deviation; SLE, systemic lupus erythematosus.
*For PPPM data, *n* denotes the number of patients.
†Mann–Whitney–Wilcoxon tests were performed using median data.
‡Including both inpatient and outpatient visits.
§For patients who received at least 1 outpatient service.
**For patients who received at least 1 inpatient service.

Among all patients in the LN cohort, the median (IQR) number of all-cause outpatient and inpatient admissions were 1.83 (4.17) and 0.11 (0.33) PPPM, respectively. The median all-cause LoS PPPM was significantly longer among patients with LN with ≥1 inpatient admission (1.89 [3.17] vs 1.50 [2.25] days, *P* = .0016; Table 2).

LN patients with ESKD had numerically greater median (IQR) total all-cause healthcare visits PPPM compared with LN patients without ESKD (3.00 [4.18] vs 1.50 [3.45]). Among patients with ≥1 outpatient visit, median outpatient visits were greater among LN patients with ESKD vs LN patients without ESKD (3.00 [5.00] vs 2.42 [3.85]). Median inpatient admissions were similar among LN patients with ESKD compared with LN patients without ESKD, for those with ≥1 inpatient admission (0.25 [0.48] vs 0.25 [0.35], Table 3). Median all-cause LoS was also higher in the LN with ESKD vs LN without ESKD cohort by number of days PPPM among patients with ≥1 inpatient admission (2.67 [3.75] vs 1.58 [2.75] days, Table 3). Disease-specific HCRU data largely reflected the all-cause data (Tables 2 and 3).

Table 3. HCRU for LN patients with ESKD and LN patients without ESKD.

HCRU	LN patients with ESKD (*N* = 142)			LN patients without ESKD (*N* = 262)		
	*n**	Mean (SD)	Median (IQR)	*n**	Mean (SD)	Median (IQR)
All-cause HCRU						
Number of all-cause healthcare visits PPPM						
Total†	142	4.86 (5.67)	3.00 (4.18)	262	2.71 (3.03)	1.50 (3.45)
Outpatient‡	131	4.91 (5.71)	3.00 (5.00)	205	3.17 (3.16)	2.42 (3.85)
Inpatient§	103	0.45 (0.55)	0.25 (0.48)	175	0.34 (0.32)	0.25 (0.35)
LoS, inpatient admission, days PPPM	103	4.31 (5.33)	2.67 (3.75)	175	2.48 (2.73)	1.58 (2.75)
Disease-specific HCRU						
Number of disease-specific healthcare visits PPPM						
Total†	142	1.75 (2.45)	0.96 (1.70)	262	1.16 (1.38)	0.74 (1.17)
Outpatient‡	123	1.71 (2.40)	0.92 (2.02)	185	1.37 (1.49)	0.92 (1.42)
Inpatient§	78	0.49 (0.59)	0.27 (0.51)	167	0.30 (0.28)	0.20 (0.31)
LoS, inpatient admission, days PPPM	78	4.77 (5.76)	2.90 (4.50)	167	2.22 (2.47)	1.44 (2.20)

ESKD indicates end-stage kidney disease; HCRU, healthcare resource utilization; IQR, interquartile range; LN, lupus nephritis; LoS, length of stay; PPPM, per patient per month; SD, standard deviation; SLE, systemic lupus erythematosus.
*For PPPM data, *n* denotes the number of patients.
†Including both inpatient and outpatient visits.
‡For patients who received at least 1 outpatient service.
§For patients who received at least 1 inpatient service.

Medical Costs

No statistically significant difference was found in either the median (IQR) all-cause outpatient costs per visit or all-cause inpatient costs per admission between the LN and SLE cohorts among patients with ≥1 visit (outpatient costs: $17.25 [47.97] vs $18.98 [46.66]; inpatient costs: $722.92 [1131.32] vs $681.36 [1076.34]; Table 4). Compared with the SLE cohort, the LN cohort had significantly higher all-cause outpatient costs PPPM for those with ≥1 outpatient visit ($97.43 [156.74] vs $36.49 [89.26], $P < .0001$) and higher all-cause inpatient costs PPPM for patients with ≥1 inpatient admission ($297.73 [520.12] vs $189.21 [322.17], $P < .0001$, Table 4). Among all patients in the LN cohort, the median all-cause outpatient and inpatient costs PPPM were $74.93 (149.88) and $140.25 (476.42), respectively. All disease-specific costs were higher for patients in the LN cohort compared with the SLE cohort (Table 4). Data for costs in 2017 CNY are listed in Appendix Table 4 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2024.101001.

Numerically higher all-cause medical costs PPPM were observed for LN patients with ESKD ($466.29 [958.90]) vs LN patients without ESKD ($223.50 [319.56]; Table 5). All-cause drug and nondrug costs PPPM for LN patients with ESKD were approximately double those for LN patients without ESKD (drug cost: $238.55 [374.90] vs $111.72 [160.89]; nondrug cost: $178.57 [508.79] vs $94.77 [161.62]; Table 5). Data for costs in 2017 CNY are listed in Appendix Table 5 in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2024.101001. The greatest contributors to the observed all-cause cost differences between patients with ESKD and patients without ESKD were costs related to antibiotics (mean [SD]: $39.76 [113.61] vs $15.33 [45.53], median [IQR]: $1.18 [35.46] vs $0.85 [8.25], respectively), dialysis (mean [SD] $121.50 [288.48] vs $0 [0], median [IQR] $0 [36.52] vs $0 [0]), other nondrug treatment (mean [SD]: $108.22 [176.57] vs $54.33 [115.24], median [IQR] $45.72 [101.88] vs $20.04 [47.91]), medical consumables (mean [SD]: $64.16 [218.99] vs $15.27 [61.60], median [IQR] $4.81 [32.73] vs $2.53 [8.75]), and surgery (mean [SD]: $14.41 [36.19] vs $4.49 [18.16], median [IQR] $0.07 [14.38] vs $0 [0.49]).

All-cause outpatient and inpatient costs were higher in LN patients with ESKD vs LN patients without ESKD (Table 5). The findings for the disease-specific medical costs generally reflected the all-cause medical cost data (Tables 4 and 5).

Discussion

In a Chinese clinical setting, patients with LN had a greater HCRU and higher hospital costs PPPM compared with patients with SLE (with or without LN), with the burden being even greater for LN patients with ESKD. These data highlight the need for early diagnosis and more effective treatment of SLE and LN to prevent progression to ESKD, and potentially mitigate the economic burden observed in these patients.

Given the difficulties in accessing Chinese retrospective claims databases, very few nationwide studies to date have investigated the economic impact of LN in a real-world clinical setting. One study conducted in China showed that the average hospitalization cost for patients with LN was $2109.26, with drug costs accounting for the highest proportion of this value ($1041.41, 49%).[23]

Table 4. All-cause and disease-specific medical costs for the SLE and LN cohorts.

Medical costs	General SLE cohort (*N* = 3645)			LN cohort (*n* = 404)			*P* value[†]
	*n**	Mean (SD)	Median (IQR)	*n**	Mean	Median (IQR)	
All-cause costs, USD ($) 2022							
Outpatient costs per outpatient visit	63 309	40.27 (82.32)	18.98 (46.66)	14 502	40.88 (80.57)	17.25 (47.97)	.1136
Inpatient costs per inpatient admission	4768	1276.14 (2251.68)	681.36 (1076.34)	1007	1425.78 (2481.34)	722.92 (1131.32)	.1499
Total costs PPPM[‡]	3797	278.71 (544.35)	113.09 (267.39)	404	525.89 (778.61)	287.46 (477.15)	<.0001
Outpatient costs PPPM[§]	3216	88.91 (195.79)	36.49 (89.26)	336	160.34 (204.26)	97.43 (156.74)	<.0001
Inpatient costs PPPM**	1953	395.46 (655.99)	189.21 (322.17)	278	570.46 (851.26)	297.73 (520.12)	<.0001
Disease-specific costs, USD ($) 2022							
Outpatient costs per outpatient visit	21 000	62.44 (114.52)	42.71 (55.46)	5206	68.51 (114.09)	50.14 (57.07)	<.0001
Inpatient costs per inpatient admission	3231	1148.21 (2017.03)	627.28 (967.45)	835	1351.82 (2326.22)	722.92 (1050.95)	.022
Total costs PPPM[‡]	3797	174.63 (411.87)	58.42 (155.67)	404	396.22 (723.31)	165.49 (329.44)	<.0001
Outpatient costs PPPM[§]	2761	62.03 (191.61)	20.01 (55.82)	308	104.95 (161.04)	56.22 (119.85)	<.0001
Inpatient costs PPPM**	1597	307.96 (534.85)	154.21 (243.96)	245	521.43 (843.35)	243.28 (482.16)	<.0001

IQR indicates interquartile range; LN, lupus nephritis; PPPM, per patient per month; SD, standard deviation; SLE, systemic lupus erythematosus; USD, US dollars.
*For PPPM data, *n* denotes the number of patients; for per visit data, *n* denotes the total number of visits.
[†]Mann–Whitney–Wilcoxon tests were performed using median data.
[‡]Including both inpatient and outpatient visits.
[§]For patients who received at least 1 outpatient service.
**For patients who received at least 1 inpatient service.

Table 5. All-cause and disease-specific medical costs among patients in the LN cohort with and without ESKD.

Medical costs	Patients with ESKD (*N* = 142)			Patients without ESKD (*N* = 262)		
	*n**	Mean (SD)	Median (IQR)	*n**	Mean (SD)	Median (IQR)
All-cause costs PPPM, USD ($) 2022						
Total costs[†]	142	814.74 (983.07)	466.29 (958.90)	262	369.34 (586.50)	223.50 (319.56)
Drug costs[‡]	142	351.17 (416.02)	238.55 (374.90)	262	187.14 (352.65)	111.72 (160.89)
Nondrug costs[§]	142	463.58 (657.32)	178.57 (508.79)	262	182.20 (280.41)	94.77 (161.62)
Outpatient costs**	131	212.57 (274.54)	118.33 (214.14)	205	126.96 (132.71)	84.80 (125.00)
Inpatient costs[††]	103	852.89 (1023.71)	528.38 (922.43)	175	404.24 (681.36)	246.51 (386.40)
Disease-specific costs PPPM, USD ($) 2022						
Total costs[†]	142	597.11 (961.88)	224.29 (812.36)	262	287.35 (523.57)	152.55 (242.17)
Drug costs[‡]	142	228.41 (379.53)	107.26 (313.18)	262	153.49 (340.47)	83.62 (125.45)
Nondrug costs[§]	142	368.70 (648.64)	75.92 (413.56)	262	133.86 (231.10)	64.93 (119.61)
Outpatient costs**	123	131.24 (226.50)	39.55 (149.04)	185	87.47 (92.12)	62.65 (94.09)
Inpatient costs[††]	78	880.08 (1106.67)	583.03 (937.28)	167	353.91 (623.42)	187.61 (266.11)

ESKD indicates end-stage kidney disease; IQR, interquartile range; LN, lupus nephritis; PPPM, per patient per month; SD, standard deviation; USD, US dollars.
*For PPPM data, *n* denotes the number of patients.
[†]Including both inpatient and outpatient visits.
[‡]Disease-specific drug costs included antimalarials, glucocorticoids, immunosuppressors, cyclophosphamide, and rituximab, and other drug costs included antiinfectives and antibiotics.
[§]Nondrug costs included lab test costs, imaging examinations, surgery, inpatient stay (bed cost charged per day as part of inpatient service), nursing, medical consumables, and dialysis.
**For patients who received at least 1 outpatient service.
[††]For patients who received at least 1 inpatient service.

A national claims database study of patients with SLE in China also showed considerable HCRU and medical costs for Chinese patients.[21]

The findings of this study are in line with earlier studies in different clinical settings and patient populations. In a 2011 structured literature review of SLE in a US setting, mean annual direct costs associated with LN were $29 034 to $62 651, whereas costs for those without LN were $12 273 to $16 575.[24] A 2021 systematic literature review of 22 studies (13 from North America, 7 from Asia, and 2 from Europe) reported a high economic burden of LN, particularly among patients with active or severe disease.[18]

This study also demonstrates the substantial economic burden on hospitals of ESKD among patients with LN in China. Although this is the first study to report on this burden in China, these data support findings from studies conducted in other regions. A US study (published in 2009) that investigated the long-term medical costs of ESKD among patients with LN showed that annual medical costs increased from $47 660 at year 1 to $106 982 at year 5 of follow-up among patients with ESKD, compared with $18 002 and $38 434, respectively, among LN patients without ESKD.[25] Additionally, a study conducted in the Philippines identified that ESKD was a significant independent variable that contributed to the direct annual healthcare costs of patients with SLE.[26] In this study, the greatest contributors to higher ESKD costs were related to antibiotics, dialysis, medical consumables, surgery, and other nondrug treatments, compared with patients without ESKD, aligning with previous research that indicated that dialysis and surgery are the largest contributors to the economic burden of ESKD.[18,27]

There are limited treatment options for LN in China, and fewer treatments existed in 2017 when these data were generated. Because of the progressive nature of LN and subsequent increased medical and economic burden of ESKD, early diagnosis and initiation of disease-modifying dugs that can slow or prevent the progression of LN to ESKD are critical to improve LN disease outcomes and to decrease the economic burden and HCRU of LN-associated ESKD in China.

Patient matching was not conducted for the cohorts, meaning that it is not possible to rule out demographic or clinical characteristic drivers being responsible for the cost differences seen in this study. However, previous studies also highlight a higher economic burden in patients with LN or ESKD compared with SLE,[25,28,29] indicating that earlier intervention and management of SLE should help avoid the later surge in HCRU and costs associated with disease progression.

This study had several limitations. Eligible patients were identified based on the presence of keywords and ICD-10 diagnosis codes on medical claims; therefore, the lack of laboratory test data and historic clinical information may have resulted in missing counts of patients. Only data from 2017 were available, meaning that follow-up times were limited to 1 year at most; therefore, long-term costs, such as dialysis and the cost of other organ damage accrual could not be accurately captured. Therefore, ESKD-associated costs may be underestimated. Approximately 11% of patients with SLE had LN in this study; this is lower than proportions reported elsewhere (30% to 70% in Asian populations).[17] This suggests that the prevalence of LN may be underreported here, which could be related to the lack of laboratory tests and biopsy data, misdiagnosis, or low use of ICD-10 codes and diagnosis keywords for LN in the claims database. Additionally, it could mean that only the most severe LN cases were identified in this study. Because patients with SLE alone (ie, without LN) were not identified in the CHIRA-approved analysis, hospital HCRU and hospital medical costs for LN could only be compared with a general SLE cohort, irrespective of concomitant LN diagnoses. This may have resulted in reduced differences in hospital HCRU and hospital medical costs for LN vs SLE (with or without LN) compared with an analysis of LN vs SLE alone. These cost analyses only reflect the standard therapy in China in 2017 and do not include the use of recently approved therapies in China for the

treatment of active SLE or LN (such as belimumab and telitacicept). Additionally, some disease-specific costs may not have been captured because of coding decisions. Given the heterogeneity of SLE, treating physicians may not have included a diagnosis code or keyword for SLE or LN on every medical claim.[30,31] Finally, follow-up times varied between patients; analysis of PPPM costs was performed to address the issue of variability in length of follow-up.

Despite these limitations, these findings are relevant and generalizable to the Chinese clinical setting because they reflect real-world hospital HCRU and hospital medical costs based on the current standard therapy in mainland China. These findings highlight the need to mitigate the economic and clinical burden observed in China among patients with LN, especially those with ESKD.

Author Disclosures

Author disclosure forms can be accessed below in the Supplemental Material section.

Supplemental Material

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