Supplementary Material

1 Supplementary Tables

1.1 Supplementary Table 1. Logistic regression formulas used for ROC analysis to predict active lesions.

Model name	R formula used for logistic regression
SS	GLM.1 <- glm(Active.lesion ~ SS + Exam.date, family=binomial(logit), data=Dataset)
ds-DNA	GLM.2 <- glm(Active.lesion ~ ds.DNA, family=binomial(logit), data=Dataset)
ds-DNA+SS	GLM.3 <- glm(Active.lesion ~ ds.DNA + SS + Exam.date, family=binomial(logit), data=Dataset)
C3	GLM.4 <- glm(Active.lesion ~ C3, family=binomial(logit), data=Dataset)
C3+SS	GLM.5 <- glm(Active.lesion ~ C3 + SS + Exam.date, family=binomial(logit), data=Dataset)
C4	GLM.6 <- glm(Active.lesion ~ C4, family=binomial(logit), data=Dataset)
C4+SS	GLM.7 <- glm(Active.lesion ~ C4 + SS + Exam.date, family=binomial(logit), data=Dataset)
eGFR	GLM.8 <- glm(Active.lesion ~ eGFR, family=binomial(logit), data=Dataset)
eGFR+SS	GLM.9 <- glm(Active.lesion ~ eGFR + SS + Exam.date, family=binomial(logit), data=Dataset)
U-TP	GLM.10 <- glm(Active.lesion ~ UTP.Cr, family=binomial(logit), data=Dataset)
U-TP+SS	GLM.11 <- glm(Active.lesion ~ UTP.Cr + SS + Exam.date, family=binomial(logit), data=Dataset)
SLEDAI	GLM.12 <- glm(Active.lesion ~ SLEDAI, family=binomial(logit), data=Dataset)
SLEDAI+SS	GLM.13 <- glm(Active.lesion ~ SLEDAI + SS + Exam.date, family=binomial(logit), data=Dataset)
C3+C4+ds-DNA	GLM.14 <- glm(Active.lesion ~ C3 + C4 + ds.DNA, family=binomial(logit), data=Dataset)
C3+C4+ds-DNA+SS	GLM.15 <- glm(Active.lesion ~ C3 + C4 + ds.DNA + SS + Exam.date, family=binomial(logit), data=Dataset)
C3+eGFR+ds-DNA	GLM.16 <- glm(Active.lesion ~ C3 +eGFR +ds.DNA, family=binomial(logit), data=Dataset)
C3+eGFR+ds-DNA+SS	GLM.17 <- glm(Active.lesion ~ C3 +eGFR +ds.DNA + SS + Exam.date, family=binomial(logit), data=Dataset)

C3, Complement 3; C4, Complement 4; ds-DNA, Double-stranded DNA antibodies; eGFR, estimated glomerular filtration rate; SLEDAI, Systemic Lupus Erythematosus Disease Activity Index; SS, Serum sulfatide; U-TP, Urinary total protein to creatinine ratio.

1.2 Supplementary Table 2. Patient characteristics

Variable	LN (N=64)	Donor (N=23)	*P*-value
Age (years)	40.3 ± 14.0	56.8 ± 8.4	<0.001
Male sex (n)	8 (12.5)	10 (43.5)	0.005
Body mass index (kg/m^2)	21.9 [20.4, 24.0]	23.2 [21.2, 24.5]	0.32
Mean blood pressure (mmHg)	91.3 [80.0, 103.7]	88.3 [79.3, 93.3]	0.25
Hypertension (n)	17 (26.6)	4 (17.4)	0.57
Diabetes mellitus (n)	3 (4.7)	3 (13.0)	0.19
Symptoms			
Rash (n)	28 (43.8)	0 (0)	<0.001
Arthritis (n)	14 (21.9)	0 (0)	0.02
Serositis (n)	5 (7.8)	0 (0)	0.32
Pulmonary involvement (n)	7 (10.9)	0 (0)	0.18
SLEDAI	17.7 ± 6.17	N/A	—
Laboratory data			
Albumin (g/dL)	3.0 [2.5, 3.4]	4.4 [4.1, 4.6]	<0.001
Creatinine (mg/dL)	0.73 [0.60, 1.03]	0.72 [0.64, 0.81]	0.54
eGFR (mL/min/1.73 m^2)	74.2 ± 30.0	75.2 ± 11.5	0.87
CRP (mg/dL)	0.1 [0.03, 0.40]	0.03 [0.01, 0.08]	0.002

TC (mg/dL)	200 [166, 250]	201 [191, 234]	0.52
LDL-C (mg/dL)	118 [88, 150]	115 [107, 143]	0.78
TG (mg/dL)	155 [107, 316]	132 [83, 184]	0.06
White blood cell (/μL)	4805 [3718, 6143]	5520 [4415, 6115]	0.27
Hemoglobin (g/dL)	11.7 ± 1.9	14.2 ± 1.0	<0.001
Platelet ($\times 10^4$/μL)	20.2 ± 7.7	24.6 ± 5.0	0.01
Immunological data			
Complement 3 (mg/dL)	44 [31, 69]	N/A	—
Complement 4 (mg/dL)	5.9 [3.7, 13.2]	N/A	—
Complement hemolytic 50% (U/mL)	19.3 [7.1, 35.7]	N/A	—
ANA ≥ 1:80 (n)	50 (94.3)	N/A	—
ds-DNA antibodies (IU/mL)	51.2 [12.7, 159.0]	N/A	—
Urinalysis			
Hematuria (n)	41 (64.1)	0 (0)	<0.001
Urine protein (g/gCr)	2.04 [1.13, 4.15]	0.00 [0.00, 0.00]	<0.001
Medications at admission			
Prednisolone (mg/day)	6.75 [0.00, 15.00]	N/A	—
Calcineurin inhibitor (n)	14 (21.9)	N/A	—
Mycophenolate mofetil (n)	5 (7.8)	N/A	—
Hydroxychloroquine (n)	3 (4.7)	N/A	—
Mizoribine (n)	5 (7.8)	N/A	—

Continuous variables are presented as mean ± standard deviation or median [interquartile range], and categorial variables are presented as n (%). Continuous variables are compared using either Student's t-test or the Mann–Whitney U test, depending on whether the variables are normally or non-normally distributed. Categorical variables are compared using Fisher's exact test. Statistical significance is set at *P*-value < 0.05. ANA, antinuclear antibody; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; N/A, not assessed; SLEDAI, Systemic Lupus Erythematosus Disease Activity Index; TC, total cholesterol; TG, triglyceride.

1.3 Supplementary Table 3. Regression analysis of SS level with 95% CI for pairwise disease group comparisons

	Univariate		Multivariate	
	Odds ratio (95% CI)	*P*-value	Odds ratio (95% CI)	*P*-value
II vs. III	1.12 (−2.56, 4.82)	0.53	0.63 (−3.68, 4.96)	0.76
II vs. IV	2.05 (−0.55, 4.64)	0.12	1.43 (−1.13, 4.01)	0.26
II vs. V	0.61 (−4.41, 5.64)	0.8	1.60 (−4.96, 8.17)	0.59
II vs. donor	1.18 (−0.94, 3.31)	0.26	1.39 (−0.60, 3.40)	0.17
III vs. IV	1.27 (0.12, 2.42)	0.03	1.37 (0.19, 2.55)	0.02
III vs. V	−0.47 (−2.30, 1.37)	0.6	−0.66 (−2.64, 1.30)	0.5
III vs. donor	−0.88 (−2.82, 1.05)	0.36	−0.86 (−2.79, 1.06)	0.37
IV vs. V	−1.75 (−3.13, −0.37)	0.01	−1.50 (−2.93, −0.06)	0.04
IV vs. donor	−2.64 (−4.46, −0.83)	0.005	−3.34 (−5.24, −1.42)	<0.001
V vs. donor	−0.88 (−3.84, 2.08)	0.55	−0.39 (−3.66, 2.87)	0.81

Both univariate and multivariate analyses (adjusted for age and sex) performed for regression analysis. CI, confidence interval; SS, serum sulfatide.

1.4 Supplementary Table 4. Regression analysis of SS level with 95% CI for pairwise comparison among three groups (A, A/C, and C)

	Univariate		Multivariate	
	Odds ratio (95% CI)	*P*-value	Odds ratio (95% CI)	*P*-value
A vs. A/C	0.02 (−0.05, 0.10)	0.56	0.02 (−0.05, 0.1)	0.53
A vs. C	−0.009 (−0.19, 0.01)	0.08	−0.11 (−0.22, 0.01)	0.07
A/C vs. C	−0.08 (−0.13, −0.02)	0.006	−0.08 (−0.13, −0.02)	0.006

Both univariate and multivariate analyses (adjusted for age and sex) performed for regression analysis. CI, confidence interval; SS, serum sulfatide.

1.5 Supplementary Table 5. Patient characteristics by presence of active lesions in Class III–IV LN patients.

Variable	With Active lesions (N=44)	Without Active lesions (N=6)	*P*-value
Age (years)	39.1 ± 12.7	39.2 ± 17.9	0.99
Male sex (n)	3 (6.8)	1 (16.7)	0.41
Body mass index (kg/m^2)	21.6 [20.3, 23.7]	22.2 [21.8, 25.0]	0.33
Mean blood pressure (mmHg)	96.5 [81.6, 104.5]	100.0 [88.7, 111.6]	0.24
Hypertension (n)	11 (25.0)	3 (50.0)	0.33
Diabetes mellitus (n)	1 (2.3)	0 (0.0)	1.0
Symptoms			
Rash (n)	20 (45.5)	1 (16.7)	0.38
Arthritis (n)	13 (29.5)	0 (0)	0.32
Serositis (n)	4 (9.1)	0 (0)	1.0
Pulmonary involvement (n)	4 (9.1)	1 (16.7)	0.48

SLEDAI	18.7 ± 6.7	15.5 ± 6.3	0.27
Laboratory data			
Albumin (g/dL)	3.0 [2.6, 3.3]	2.1 [2.0, 3.2]	0.14
Creatinine (mg/dL)	0.74 [0.66, 1.1]	0.95 [0.85, 1.04]	0.27
eGFR (mL/min/1.73 m^2)	71.7 ± 31.3	59.3 ± 17.4	0.35
CRP (mg/dL)	0.1 [0.04, 0.41]	0.06 [0.02, 0.26]	0.41
TC (mg/dL)	183 [146, 240]	333 [237, 386]	0.004
LDL-C (mg/dL)	104 [82, 136]	192 [141, 229]	0.004
TG (mg/dL)	152 [107, 231]	271 [161, 403]	0.07
White blood cell (/μL)	4500 [3718, 5683]	7190 [6913, 9970]	0.02
Hemoglobin (g/dL)	11.5 ± 1.9	12.4 ± 1.5	0.24
Platelet ($\times 10^4$/μL)	19.0 ± 6.6	26.7 ± 8.6	0.01
Immunological data			
Complement 3 (mg/dL)	39 [29, 55]	68 [58, 82]	0.07
Complement 4 (mg/dL)	4.7 [2.8, 10.2]	17.9 [10.2, 22.2]	0.003
Complement hemolytic 50% (U/mL)	14.3 [4.5, 28.7]	40.3 [36.1, 50.9]	0.01
ANA ≥ 1:80 (n)	41 (93.2)	5 (83.3)	0.85
ds-DNA antibodies (IU/mL)	74.5 [28.4, 266.4]	14.3 [6.0, 40.7]	0.02
Urinalysis			
Hematuria (n)	30 (68.2)	4 (66.7)	1.0
Urine protein (g/gCr)	1.90 [1.15, 4.00]	7.32 [1.84, 10.33]	0.28

Medications at admission			
Prednisolone (mg/day)	1.00 [0.00, 10.00]	8.00 [5.25, 13.75]	0.3
Calcineurin inhibitor (n)	9 (20.4)	3 (50.0)	0.47
Mycophenolate mofetil (n)	4 (9.1)	1 (16.7)	0.68
Hydroxychloroquine (n)	2 (4.5)	1 (16.7)	0.38
Mizoribine (n)	3 (6.8)	1 (16.7)	0.58

Continuous variables are presented as mean ± standard deviation or median [interquartile range], and categorial variables are presented as n (%). Continuous variables are compared using either Student's t-test or the Mann–Whitney U test, depending on whether the variables are normally or non-normally distributed. Categorical variables are compared using Fisher's exact test. Statistical significance is set at *P*-value < 0.05. A, Active; ANA, antinuclear antibody; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; N/A, not assessed; SLEDAI, Systemic Lupus Erythematosus Disease Activity Index; TC, total cholesterol; TG, triglyceride.

1.6 Supplementary Table 6. Association of active lesions with the SS level in Class III–IV LN patients

Model	Odds ratio (95% CI)	*P*-value
Crude model	0.56 (0.35, 0.91)	0.02
Model 1	0.75 (0.31, 0.88)	0.01
Model 2	0.57 (0.35, 0.92)	0.02
Model 3	0.52 (0.30, 0.90)	0.02
Model 4	0.55 (0.31, 0.96)	0.03

Odds ratios of the SS level for Class III–IV patients with active lesions adjusted for age and sex (Model 1); eGFR (Model 2); eGFR, age, and sex (Model 3); or eGFR, albumin, age, and sex (Model 4) and described with 95% CI values using univariate and multivariate logistic regression analyses. CI, confidence interval; eGFR, estimated glomerular filtration rate; LN, lupus nephritis; SS, serum sulfatide.

1.7 Supplementary Table 7. Patient characteristics by presence of active lesions in Overall LN patients.

Variable	With Active lesions (N=44)	Without Active lesions (N=20)	*P*-value
Age (years)	39.1 ± 12.7	42.9 ± 16.7	0.32
Male sex (n)	3 (6.8)	5 (25.0)	0.10
Body mass index (kg/m^2)	21.6 [20.3, 23.7]	22.2 [21.2, 25.4]	0.26
Mean blood pressure (mmHg)	96.5 [81.6, 104.5]	85.7 [76.5, 94.7]	0.08
Hypertension (n)	11 (25.0)	6 (30.0)	0.76
Diabetes mellitus (n)	1 (2.3)	2 (10.0)	0.23
Symptoms			
Rash (n)	20 (45.5)	8 (40.0)	0.79
Arthritis (n)	13 (29.5)	1 (5.0)	0.05
Serositis (n)	4 (9.1)	1 (5.0)	1.0
Pulmonary involvement (n)	4 (9.1)	3 (15.0)	0.67
SLEDAI	18.7 ± 6.7	15.4 ± 4.1	0.05
Laboratory data			
Albumin (g/dL)	3.0 [2.6, 3.3]	2.7 [2.1, 3.62]	0.35
Creatinine (mg/dL)	0.74 [0.66, 1.1]	0.67 [0.57, 0.96]	0.3
eGFR (mL/min/1.73 m^2)	71.7 ± 31.3	79.7 ± 26.9	0.33
CRP (mg/dL)	0.1 [0.04, 0.41]	0.1 [0.03, 0.32]	0.52
TC (mg/dL)	183 [146, 240]	236 [202, 333]	0.004

LDL-C (mg/dL)	104 [82, 136]	158 [118, 216]	0.004
TG (mg/dL)	152 [107, 231]	180 [101, 361]	0.35
White blood cell (/μL)	4500 [3718, 5683]	5770 [3958, 7085]	0.08
Hemoglobin (g/dL)	11.5 ± 1.9	12.1 ± 1.9	0.20
Platelet ($\times 10^4$/μL)	19.0 ± 6.6	22.8 ± 9.3	0.07
Immunological data			
Complement 3 (mg/dL)	39 [29, 55]	64 [51, 76]	0.003
Complement 4 (mg/dL)	4.7 [2.8, 10.2]	11.5 [6.9, 19.2]	0.002
Complement hemolytic 50% (U/mL)	14.3 [4.5, 28.7]	35.8 [31.0, 45.6]	0.001
ANA ≥ 1:80 (n)	41 (93.2)	18 (90.0)	0.89
ds-DNA antibodies (IU/mL)	74.5 [28.4, 266.4]	13.2 [6.1, 42.2]	0.001
Urinalysis			
Hematuria (n)	30 (68.2)	11 (55.0)	0.4
Urine protein (g/gCr)	1.90 [1.15, 4.00]	2.52 [0.89, 4.96]	0.79
Medications at admission			
Prednisolone (mg/day)	1.00 [0.00, 10.00]	5.5 [0.00, 13.12]	0.64
Calcineurin inhibitor (n)	9 (20.4)	5 (25.0)	0.87
Mycophenolate mofetil (n)	4 (9.1)	1 (5.0)	0.74
Hydroxychloroquine (n)	2 (4.5)	1 (5.0)	0.88
Mizoribine (n)	3 (6.8)	2 (10.0)	0.68

Continuous variables are presented as mean ± standard deviation or median [interquartile range], and categorial variables are presented as n (%). Continuous variables are compared using either Student's t-test or the Mann–Whitney U test, depending on whether the variables are normally or non-normally

distributed. Categorical variables are compared using Fisher's exact test. Statistical significance is set at *P*-value < 0.05. ANA, antinuclear antibody; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; N/A, not assessed; SLEDAI, Systemic Lupus Erythematosus Disease Activity Index; TC, total cholesterol; TG, triglyceride.

1.8 Supplementary Table 8. Association of active lesions with the SS level in overall LN patients

Model		*P*-value
Crude model	0.66 (0.49, 0.89)	0.006
Model 1	0.65 (0.48, 0.89)	0.007
Model 2	0.64 (0.47, 0.88)	0.006
Model 3	0.61 (0.44, 0.86)	0.004
Model 4	0.61 (0.43, 0.88)	0.007

Odds ratios of the SS levels for all LN patients with active lesions adjusted for age and sex (Model 1); eGFR (Model 2); eGFR, age, and sex (Model 3); or eGFR, albumin, age, and sex (Model 4) and described with 95% CI values using univariate and multivariate logistic regression analyses. CI, confidence interval; eGFR, estimated glomerular filtration rate; LN, lupus nephritis; SS, serum sulfatide.

1.9 Supplementary Table 9. Cutoff values, sensitivity, and specificity for individual predictors in ROC analysis

	Cutoff value	Sensitivity	Specificity
SS (nmol/mL)	6.83	0.68	0.75
ds-DNA (IU/mL)	67.9	0.6	0.85
C3 (mg/dL)	52	0.73	0.75
C4 (mg/dL)	6.9	0.67	0.75

eGFR (mL/min/1.73 m^2)	50	0.34	0.9
U-TP (g/gCr)	4.03	0.8	0.35
SLEDAI	17	0.58	0.79

The cut-off value, sensitivity, and specificity are determined using the Youden index. C3, complement 3; C4, complement 4; eGFR, estimated glomerular filtration rate; SLEDAI, Systemic Lupus Erythematosus Disease Activity Index; ROC, receiver operating characteristic; SS, serum sulfatide; U-TP, urinary total protein.