

Supplementary Table A1. Codes used to identify COVID-19 test, adverse outcomes and other variables of interest.

Group Description	Diagnosis Codes	Procedure Codes	HCPCS Codes unless otherwise specified
COVID-19 test (also required positive test results)	U07.1, U07.2, U07.3, B97.29, B97.29 on or after 2/20/20		HCPCS: 86328, 86769, 87635, G2023, G2024, U0001, U0002, U0003 LOINC: 94534-5, 94500-6, 94503-0, 94505-5, 94506-3, 94504-8, 94507-1, 94509-7, 94508-9, 94510-5, 94308-4, 94309-2, 94311-8, 94312-6, 94314-2, 94315-9, 94316-7, 94533-7, 94531-1, 94547-7, 94564-2, 94562-6, 94563-4, 94565-9, 94307-6, 94559-2, 94306-8, 94558-4, 94511-3
Mechanical Ventilation		5A1955Z, 5A1935Z, 5A1945Z, 5A093, 5A094, 5A095, 0BH13EZ, 0BH17EZ, 0BH18EZ	94002, 94003, 31500
Intensive Care Unit (ICU)			1) In the "carearea" file where the variable "carearea" included "Intensive Care Unit") 2) By Revenue center code in the procedure file: 0200 General classification ICU 0201 Surgical ICU 0202 Medical ICU 0203 Pediatric ICU 0204 Psychiatric ICU 0206 Intermediate ICU 0207 Burn care 0208 Trauma care 0209 Other intensive care

			0210 General classification cardiac care unit (CCU) 0211 Myocardial infarction care 0212 Pulmonary care 0213 Heart transplant 0214 Intermediate CCU 0219 Other coronary care
Hospitalization			In the “visit” file where the variable “visit_type” included “Inpatient”.

Abbreviations: ICD, International Classification of Diseases; HCPCS, Healthcare Common Procedure Coding System; CPT, Current Procedural Terminology.

Supplementary Table A2. Generic names and HCPCS codes for SLE drugs

Class	Mode of delivery	Drug Name	HCPCS
Glucocorticoids	IV	Dexamethasone	J1100, J1094
		Hydrocortisone	J1710, J1720, J1700 (20mg)
		Methylprednisolone Succinate	J2930, J2920, J1020 (20mg), J1030 (40mg), J1040 (80mg)
	Oral	Cortisone Acetate	N/A
		Dexamethasone	N/A
		Fludrocortisone	N/A
		Hydrocortisone	N/A
		Methylprednisolone	J7509 (oral 4mg)
		Prednisolone	J7510 (oral 5mg), J7512 (oral 1mg)
	IM	Prednisone	J7506 (5mg oral)
		Betamethasone	J0702 (3mg), J0704 (4mg)
		Triamcinolone Acetonide	J3300 (acetonide 1mg), J3301 (acetonide 10mg), J3302 (diacetate 5mg), J3303 (hexacetonide 5mg)
Biologic Medications	IV	Rituximab	J9310, J9311, J9312
		Belimumab	J0490
	Subcutaneous	Belimumab	N/A

Immunosuppressants	IV	Azathioprine	J7501
		Cyclophosphamide	J9070
		Mycophenolate mofetil	J7517
		Cyclosporine	J7516
		Tacrolimus	J7525
	Subcutaneous	Methotrexate	J9250, J9260
	Oral	Azathioprine	J7500
		Methotrexate	N/A
		Cyclophosphamide	J8530
		Mycophenolate mofetil	N/A
		Mycophenolate sodium	N/A
		Cyclosporine	J7515, J7502
		Tacrolimus	J7503, J7507, J7508
	Leflunomide		
Antimalarials	Oral	Hydroxychloroquine	N/A
		Quinacrine	N/A
		Chloroquine	J0390 (injection, up to 250mg)

HCPCS, Healthcare Common Procedure Coding System.

Supplementary Table A3. Baseline characteristics of unmatched cohorts.

	SLE N (%)	Control N (%)	P
Total (N)	687	579224	
Age, years			
18-39	167 (24.3)	193535 (33.4)	<0.001
40-49	137 (19.9)	90929 (15.7)	
50-54	72 (10.5)	52023 (9)	
55-59	69 (10)	54164 (9.4)	
60-64	89 (13)	51937 (9)	
65-69	58 (8.4)	41465 (7.2)	
70-74	42 (6.1)	32656 (5.6)	
75-79	27 (3.9)	23851 (4.1)	
80-84	18 (2.6)	17422 (3)	
85+	8 (1.2)	21242 (3.7)	
Gender			
Female	631 (91.8)	323463 (55.8)	<0.001
Male	56 (8.2)	255761 (44.2)	
Race			
Hispanic	93 (13.5)	63733 (11)	<0.001
NH Asian	11 (1.6)	11677 (2)	
NH Black	232 (33.8)	85730 (14.8)	
NH White	310 (45.1)	359945 (62.1)	
Other / Unknown	41 (6)	58139 (10)	
COVID-19 diagnosis quarter*			
1	66 (9.6)	33232 (5.7)	<0.001
2	242 (35.2)	166647 (28.8)	
3	214 (31.1)	192554 (33.2)	
4	165 (24)	186791 (32.2)	
Severe obesity (BMI ≥ 40)			
No	581 (84.6)	524820 (90.6)	<0.001
Yes	106 (15.4)	54404 (9.4)	
Comorbidities			
0	92 (13.4)	366436 (63.3)	<0.001
1	97 (14.1)	88991 (15.4)	
2+	498 (72.5)	123797 (21.4)	
Region			
Midwest	318 (46.3)	315836 (54.5)	<0.001
Northeast	200 (29.1)	122761 (21.2)	
South	103 (15)	89553 (15.5)	
West	31 (4.5)	27395 (4.7)	
Other	35 (5.1)	23679 (4.1)	

Supplementary Table A4. Sensitivity analysis including SLE patients not receiving SLE drug therapy. Baseline characteristics of SLE cases with matched controls diagnosed with COVID-19

	SLE N (%)	Control N (%)	P
Total (N)	1209	12090	
Age, years			
18-39	297 (24.6)	2970 (24.6)	1
40-49	241 (19.9)	2410 (19.9)	
50-54	131 (10.8)	1313 (10.9)	
55-59	121 (10)	1204 (10)	
60-64	160 (13.2)	1603 (13.3)	
65-69	106 (8.8)	1049 (8.7)	
70-74	77 (6.4)	772 (6.4)	
75-79	41 (3.4)	419 (3.5)	
80-84	25 (2.1)	250 (2.1)	
85+	10 (0.8)	100 (0.8)	
Gender			
Female	1103 (91.2)	11030 (91.2)	1
Male	106 (8.8)	1060 (8.8)	
Race			
Hispanic	154 (12.7)	1540 (12.7)	1
NH Asian	22 (1.8)	220 (1.8)	
NH Black	419 (34.7)	4190 (34.7)	
NH White	546 (45.2)	5460 (45.2)	
Other / Unknown	68 (5.6)	680 (5.6)	
COVID-19 diagnosis quarter*			
1	99 (8.2)	990 (8.2)	1
2	423 (35)	4230 (35)	
3	381 (31.5)	3810 (31.5)	
4	306 (25.3)	3060 (25.3)	
Severe obesity (BMI ≥ 40)			
No	1038 (85.9)	10388 (85.9)	0.95
Yes	171 (14.1)	1702 (14.1)	
Smoking status			
Never	749 (62)	8251 (68.2)	<0.001
Current	232 (19.2)	1659 (13.7)	
Former	228 (18.9)	2180 (18)	
Comorbidities			
0	293 (24.2)	7131 (59)	<0.001
1	206 (17)	2200 (18.2)	
2+	710 (58.7)	2759 (22.8)	

Skilled nurse facility in 3 months before COVID-19 diagnosis			
No	1188 (98.3)	12009 (99.3)	<0.001
Yes	21 (1.7)	81 (0.7)	
Insurance			
Commercial	634 (52.4)	6954 (57.5)	<0.001
Medicare	280 (23.2)	1604 (13.3)	
Medicaid	117 (9.7)	1003 (8.3)	
Other insurance	41 (3.4)	567 (4.7)	
Uninsured	1 (0.1)	191 (1.6)	
Unknown	136 (11.2)	1771 (14.6)	
Region			
Midwest	551 (45.6)	6136 (50.8)	<0.001
Northeast	363 (30)	2672 (22.1)	
South	192 (15.9)	2239 (18.5)	
West	59 (4.9)	556 (4.6)	
Other	44 (3.6)	487 (4)	

Abbreviations: SLE, systemic lupus erythematosus; NH, non-Hispanic; BMI, body mass index; ICU, intensive care unit.

Supplementary Table A5. Sensitivity analysis including SLE patients not receiving SLE drug therapy. COVID-19 outcomes in SLE patients versus matched controls

	SLE (N = 1209) N (%)	Control (N=12090) N (%)	P
30-day mortality			
Yes	40 (3.3)	224 (1.9)	< 0.001
30-day mechanical ventilation			
Yes	49 (4.1)	306 (2.5)	0.002
30-day hospitalization			
Yes	319 (26.4)	2143 (17.7)	<0.001
30-day ICU without ventilation			
Yes	78 (6.5)	451 (3.7)	<0.001

Abbreviations: SLE, systemic lupus erythematosus.

Supplementary Table A6. Sensitivity analysis including SLE patients not receiving SLE drug therapy. Multivariable logistic regression model of COVID-19 outcomes in SLE patients compared to matched controls

	Model 1 ^a Odds Ratio (95% CI)	Model 2 ^b Odds Ratio (95% CI)	Model 3 ^c Odds Ratio (95% CI)	Model 4 ^d Odds Ratio (95% CI)
30-day mortality				
Control	1	1	1	1
SLE	1.93 (1.35-2.76)	1.91 (1.33-2.74)	1.29 (0.90-1.87)	1.31 (0.87-1.97)
30-day mechanical ventilation				
Control	1	1	1	1
SLE	1.62 (1.18-2.24)	1.61 (1.17-2.23)	1.09 (0.78-1.51)	1.09 (0.76-1.58)
30-day hospitalization				
Control	1	1	1	1
SLE	1.67 (1.44-1.93)	1.63 (1.41-1.89)	1.16 (0.99-1.35)	1.21 (1.02-1.42)
30-day ICU without mechanical ventilation				
Control	1	1	1	1
SLE	1.82 (1.41-2.35)	1.80 (1.39-2.32)	1.23 (0.95-1.61)	1.27 (0.95-1.69)

Abbreviations: SLE, systemic lupus erythematosus; CI: confidence interval.

^aModel 1 includes adjustments for age, gender, race, COVID-19 quarter diagnosis, insurance, and region.

^bModel 2 includes adjustments from model 1 and obesity, smoking status, skilled nursing facility admission within three months before COVID-19 diagnosis.

^cModel 3 includes adjustments from Model 2 and for number of comorbidities (0, 1, or 2+) excluding SLE.

^dModel 4 includes adjustments for model 2 and for individual comorbidities.

Supplementary Table A7. COVID-19 outcomes among patients with SLE according to baseline characteristics

	Total (N=687) N (Column %)	30-day Mortality (N=25) N (Row %)	P	30-d Mechanical Ventilation (N=41) N (Row %)	P	30-day Hospitalization (N=213) N (Row %)	P	30-day ICU Excluding Ventilation (N=49) N (Row %)	P
Garris index									
Mild	371 (54)	10 (2.7)	0.15	14 (3.8)	<0.001	88 (23.7)	<0.001	27 (7.3)	0.93
Moderate	212 (30.9)	8 (3.8)		11 (5.2)		69 (32.5)		14 (6.6)	
Severe	104 (15.1)	7 (6.7)		16 (15.4)		56 (53.8)		8 (7.7)	
Age									
18-49	304 (44.3)	4 (1.3)	0.002*	17 (5.6)	0.80	75 (24.7)	< 0.001	15 (4.9)	0.002*
50-59	141 (20.5)	5 (3.5)		7 (5.0)		36 (25.5)		5 (3.5)	
60-69	147 (21.4)	7 (4.8)		10 (6.8)		59 (40.1)		14 (9.5)	
70-79	69 (10.0)	5 (7.2)		6 (8.7)		29 (42)		10 (14.5)	
80+	26 (3.8)	4 (15.4)		1 (3.8)		14 (53.8)		5 (19.2)	
Sex									
Female	631 (91.8)	23 (3.6)	1.0*	38 (6)	1.0*	192 (30.4)	0.27	42 (6.7)	0.10
Male	56 (8.2)	2 (3.6)		3 (5.4)		21 (37.5)		7 (12.5)	
Race and ethnicity									
Hispanic	93 (13.5)	2 (2.2)	0.55*	4 (4.3)	0.42*	43 (46.2)	<0.001	11 (11.8)	0.18*
NH Asian	11 (1.6)	0		0		0		0	
NH Black	232 (33.8)	12 (5.2)		18 (7.8)		78 (33.6)		11 (4.7)	
NH White	310 (45.1)	11 (3.5)		15 (4.8)		78 (25.2)		23 (7.4)	
Other / Unknown	41 (6.0)	0		4 (9.8)		14 (34.1)		4 (9.8)	
COVID-19 diagnosis quarter									
1	66 (9.6)	3 (4.5)	0.68*	10 (15.2)	0.008	27 (40.9)	< 0.001	4 (6.1)	0.93*
2	242 (35.2)	7 (2.9)		14 (5.8)		111 (45.9)		19 (7.9)	
3	214 (31.1)	7 (3.3)		11 (5.1)		46 (21.5)		16 (7.5)	
4	165 (24.0)	8 (4.8)		6 (3.6)		29 (17.6)		10 (6.1)	
SNF in 3 months before COVID diagnosis									
No	671 (97.7)	22 (3.3)	0.02*	37 (5.5)	0.02*	206 (30.7)	0.26	48 (7.2)	1.0*

Yes	16 (2.3)	3 (18.8)		4 (25.0)		7 (43.8)		1 (6.3)	
Severe obesity (BMI ≥ 40)									
No	581 (84.6)	23 (4.0)	0.40*	31 (5.3)	0.10	182 (31.3)	0.67	47 (8.1)	0.02
Yes	106 (15.4)	2 (1.9)		10 (9.4)		31 (29.2)		2 (1.9)	
Smoking status									
Never	400 (58.2)	14 (3.5)	0.72*	20 (5.0)	0.15	104 (26.0)	< 0.001	25 (6.3)	0.56
Current	137 (19.9)	4 (2.9)		13 (9.5)		67 (48.9)		11 (8.0)	
Former	150 (21.8)	7 (4.7)		8 (5.3)		42 (28.0)		13 (8.7)	
Insurance									
Commercial	338 (49.2)	9 (2.7)	0.38*	23 (6.8)	0.52*	114 (33.7)	0.002	21 (6.2)	0.44*
Medicare	170 (24.7)	8 (4.7)		11 (6.5)		62 (36.5)		18 (10.6)	
Medicaid	77 (11.2)	3 (3.9)		2 (2.6)		12 (15.6)		4 (5.2)	
Other insurance	23 (3.3)	2 (8.7)		2 (8.7)		9 (39.1)		1 (4.3)	
Unknown	79 (11.5)	3 (3.8)		3 (3.8)		16 (20.3)		5 (6.3)	
Region									
Midwest	318 (46.3)	10 (3.1)	0.38*	18 (5.7)	0.08*	74 (23.3)	<0.001	22 (6.9)	0.12*
Northeast	200 (29.1)	7 (3.5)		7 (3.5)		85 (42.5)		16 (8.0)	
South	103 (15.0)	5 (4.9)		8 (7.8)		36 (35.0)		3 (2.9)	
West	31 (4.5)	0		4 (12.9)		8 (25.8)		5 (16.1)	
Other	35 (5.1)	3 (8.6)		4 (11.4)		10 (28.6)		3 (8.6)	

Abbreviations: SLE, systemic lupus erythematosus; NH, non-Hispanic; BMI, body mass index; ICU, intensive care unit; SNF, skilled nurse facility.

*Fisher's exact test.

Supplementary Table A8. Unadjusted rates of COVID-19 outcomes according to treatment in patients with SLE

	Total (N=687) N (Column %)	30-day Mortality (N=25) N (Row %)	P	30-d Mechanical Ventilation (N=41) N (Row %)	P	30-day Hospitalization (N=213) N (Row %)	P	30-day ICU excluding Ventilation (N=49) N (Row %)	P
Steroid average daily dose (mg) in 1 month before COVID-19 diagnosis									
0	600 (87.3)	22 (3.7)	0.63*	32 (5.3)	0.12*	173 (28.8)	0.002	39 (6.5)	0.14*
>0 to <7.5	71 (10.3)	2 (2.8)		7 (9.9)		35 (49.3)		9 (12.7)	
≥7.5	16 (2.3)	1 (6.3)		2 (12.5)		5 (31.3)		1 (6.3)	
Steroid in 3 months before COVID-19 diagnosis									
No	498 (72.5)	15 (3.0)	0.15	24 (4.8)	0.04	130 (26.1)	<0.001	27 (5.4)	0.005
Yes	189 (27.5)	10 (5.3)		17 (9.0)		83 (43.9)		22 (11.6)	
Biologics									
No	631 (91.8)	25 (4.0)	0.25*	39 (6.2)	0.57*	197 (31.2)	0.68	45 (7.1)	1.0*
Yes	56 (8.2)	0		2 (3.6)		16 (28.6)		4 (7.1)	
Immunosuppressants									
No	436 (63.5)	15 (3.4)	0.71	27 (6.2)	0.74	119 (27.3)	0.006	32 (7.3)	0.78
Yes	251 (36.5)	10 (4.0)		14 (5.6)		94 (37.5)		17 (6.8)	
Anti-malarials									
No	379 (55.2)	15 (4.0)	0.62	20 (5.3)	0.39	121 (31.9)	0.56	32 (8.4)	0.14
Yes	308 (44.8)	10 (3.2)		21 (6.8)		92 (29.9)		17 (5.5)	
Any SLE treatment**									
No	224 (32.6)	8 (3.6)	0.94	16 (7.1)	0.36	54 (24.1)	0.007	15 (6.7)	0.76
Yes	463 (67.4)	17 (3.7)		25 (5.4)		159 (34.3)		34 (7.3)	

Abbreviations: SLE, Systemic Lupus Erythematosus; ICU, intensive care unit.

*Fisher's exact test.

Except for steroids as specified, other treatments were evaluated in 6 months before COVID-19 diagnosis.

**Any steroids in 3 months or any biologics, immunosuppressants, anti-malarials in 6 months before COVID-19 diagnosis.

Supplementary Table A9. Sensitivity analysis of unadjusted rates of composite severe outcomes according to treatment for patients diagnosed with COVID-19

	Total (N=1209) N (Column %)	No 30-Day Outcome (N=852) N (Row %)	Any 30-Day Outcome (Death, Mechanical Ventilation, ICU, Hospitalization) (N=357) N (Row %)	P
Steroids average dose in one month before COVID-19 diagnosis				
None	1099 (90.9)	786 (71.5)	313 (28.5)	0.02
Low >0 and <7.5	92 (7.6)	53 (57.6)	39 (42.4)	
Median-high ≥7.5	18 (1.5)	13 (72.2)	5 (27.8)	
Steroids in 3 months before COVID-19 diagnosis				
No	947 (78.3)	700 (73.9)	247 (26.1)	<0.001
Yes	262 (21.7)	152 (58)	110 (42)	
Azathioprine				
No	1130 (93.5)	797 (70.5)	333 (29.5)	0.86
Yes	79 (6.5)	55 (69.6)	24 (30.4)	
Cyclophosphamide				
No	1195 (98.8)	843 (70.5)	352 (29.5)	0.56*
Yes	14 (1.2)	9 (64.3)	5 (35.7)	
Cyclosporine				
No	1177 (97.4)	830 (70.5)	347 (29.5)	0.83
Yes	32 (2.6)	22 (68.8)	10 (31.3)	
Methotrexate				
No	1120 (92.6)	781 (69.7)	339 (30.3)	0.046
Yes	89 (7.4)	71 (79.8)	18 (20.2)	

Mycophenolate				
No	1045 (86.4)	754 (72.2)	291 (27.8)	0.001
Yes	164 (13.6)	98 (59.8)	66 (40.2)	
Leflunomide				
No	1182 (97.8)	835 (70.6)	347 (29.4)	0.39
Yes	27 (2.2)	17 (63)	10 (37)	
Tacrolimus				
No	1155 (95.5)	822 (71.2)	333 (28.8)	0.01
Yes	54 (4.5)	30 (55.6)	24 (44.4)	
Rituximab				
No	1186 (98.1)	840 (70.8)	346 (29.2)	0.05
Yes	23 (1.9)	12 (52.2)	11 (47.8)	
Belimumab				
No	1160 (95.9)	814 (70.2)	346 (29.8)	0.27
Yes	49 (4.1)	38 (77.6)	11 (22.4)	
Antimalarials				
No	622 (51.4)	422 (67.8)	200 (32.2)	0.04
Yes	587 (48.6)	430 (73.3)	157 (26.7)	
Any of the lupus treatment**				
No	422 (34.9)	299 (70.9)	123 (29.1)	0.83
Yes	787 (65.1)	553 (70.3)	234 (29.7)	

Abbreviations: SLE, systemic lupus erythematosus; ICU, intensive care unit.

*Fisher's exact test.

Except for steroids as specified, other treatments were evaluated in 6 months before COVID-19 diagnosis.

**Any steroids in 3 months or any biologics, immunosuppressants, anti-malarials in 6 months before COVID-19 diagnosis.