

Supplementary Table 1 Baseline information

Characteristics	
Demographic	
Gender, female, n (%)	120 (53.1)
Age, years, median[IQR]	60 [53; 67]
Age, n (%)	
<40	7 (3.1)
~49	31 (13.7)
~59	67 (29.6)
~69	78 (34.5)
>=70	43 (19.0)
Disease duration, months, median[IQR]	48.0 [12.8, 132.0]
Disease duration, months, yes, n (%)	
<= 6	38 (16.8)
~12	19 (8.4)
~24	35 (15.5)
~36	18 (8.0)
>36	116 (51.3)
Menopause of females, yes, n (%)	106 (46.9)
Abnormal BMI, yes, n (%)	60 (26.5)
BMI, kg/m ² , n (%)	
normal (18.5~23.9)	166 (73.5)
underweight (<18.5)	10 (4.4)
overweight (24~27.9)	48 (21.2)
Obese (>=28)	2 (0.9)
Disease-related	
DAS28-ESR, n (%)	
remission (<2.6 points)	0
mild (~3.2 points)	5 (2.2)
moderate (~5.1 points)	81 (35.8)
active (>5.1 points)	140 (61.9)
DAS28-CRP, n (%)	
remission (<2.6 points)	7 (3.1)
mild (~3.2 points)	16 (7.1)
moderate (~5.1 points)	93 (41.2)
active (>5.1 points)	110 (48.7)
Rheumatoid nodules, yes, n (%)	12 (5.3)
CRP elevation, yes, n (%)	180 (79.6)
CRP, mg/L, n (%)	
<=6	46 (20.4)
~10	17 (7.5)
~20	39 (17.3)
~30	23 (10.2)
~50	29 (12.9)

>50	72 (31.9)
ESR elevation, yes, n (%)	196 (86.7)
ESR, n (%)	
~15(male) or ~20(female)	30 (13.3)
~30	19 (8.4)
~50	51 (22.6)
~70	49 (21.7)
~90	35 (15.5)
>90	42 (18.6)
Baker's cyst, yes, n (%)	5 (2.2)
Overlap syndrome, yes, n (%)	
osteoarthritis	22 (9.7)
gout	6 (2.7)
secondary Sjögren syndrome	17 (7.5)
Vasculitis, yes, n (%)	2 (0.9)
Interstitial lung disease (ILD), yes, n (%)	13 (5.8)
Pulmonary arterial hypertension (PAH), yes, n (%)	
mild	22 (9.7)
moderate	3 (1.3)
severe	1 (0.4)
Felty syndrome, yes, n (%)	1 (0.4)

Long-term medication history

Initial treatment, yes, n (%)	77 (34.1)
Regular treatment, yes, n (%)	68 (30.1)
Period of GC usage, months, n (%)	
No	175 (77.4)
~6	24 (10.6)
~12	13 (5.8)
>12	14 (6.2)
Methotrexate, yes, n (%)	44 (19.5)
Leflunomide, yes, n (%)	36 (15.9)
Sulfasalazine, yes, n (%)	7 (3.1)
Tripterygium Glycosides, yes, n (%)	9 (4.0)
hydroxychloroquine, yes, n (%)	20 (8.9)
total glucosides of paeony, yes, n (%)	5 (2.2)
Iguratimod, yes, n (%)	9 (4.0)
Cyclophosphamide, yes, n (%)	0
NSAIDs, yes, n (%)	123 (54.4)
bDMARDs, yes, n (%)	20 (8.9)
Types of bDMARDs, n (%)	
adalimumab	2 (0.9)
infliximab	2 (0.9)
tocilizumab	5 (2.2)
etanercept	11 (4.9)

Statins, yes, n (%)	13 (5.8)
PPIs, yes, n (%)	15 (6.6)
Laboratory tests	
WBC, n (%)	
decreased (<4.0×10 ⁹ /L)	15 (6.7)
increased (>10.0×10 ⁹ /L)	34 (15.1)
PLT, n (%)	
decreased (<100×10 ⁹ /L)	1 (0.4)
increased (>300×10 ⁹ /L)	66 (29.2)
Leukocyturia, n (%)	
(+)	44 (19.5)
(++)	14 (6.2)
(+++)	6 (2.7)
Hematemesis, n (%)	
(+)	30 (13.3)
(++)	9 (4.0)
(+++)	3 (1.3)
Hypoalbumin (<35g/L), yes, n (%)	105 (46.5)
Blood urea nitrogen, (BUN) elevation, yes, n (%)	19 (8.4)
Serum uric acid (sUA) elevation, yes, n (%)	40 (17.7)
sUA, μmol/L, n (%)	
<420	
~500	26 (11.5)
~600	12 (5.3)
~700	4 (1.8)
>700	0
Cystatin C (CysC) elevation, yes, n (%)	15 (6.6)
β ₂ -microglobulin (β ₂ -MG) elevation, yes, n (%)	79 (35.0)
Hypercholesterolemia, mmol/L, n (%)	
borderline increased(5.2~5.71)	23 (10.2)
critical increased (5.72~6.19)	12 (5.3)
High (>=6.2)	14 (6.2)
Hypertriglyceridemia, mmol/L, yes, n (%)	
borderline increased (1.7~2.29)	15 (6.6)
High (>=2.3)	13 (5.8)
Low high-density lipoprotein (HDL), mmol/L, n (%)	
low risk (>1.55)	36 (15.9)
average risk (1.03~1.55)	60 (26.5)
High risk (<1.03)	130 (57.5)
High low-density lipoprotein (LDL), mmol/L, n (%)	
optimal (~2.59 mmol/L)	98 (43.4)
near optimal (-3.37)	68 (30.1)
borderline high (~4.12)	40 (17.7)
high (~4.90)	16 (7.1)

very high (>4.90)	4 (1.8)
Serum immunoglobulin G (IgG), n (%)	
decreased	11 (4.9)
increased	52 (23.0)
Serum IgA, n (%)	
decreased	5 (2.2)
increased	70 (31.0)
Serum IgM, n (%)	
decreased	10 (4.4)
increased	28 (12.4)
Serum Complement 3 (C3), n (%)	
decreased	7 (3.1)
increased	15 (6.6)
Serum C4, n (%)	
decreased	6 (2.7)
increased	29 (12.8)
Serum total complement, n (%)	
decreased	11 (4.9)
increased	97 (42.9)
Rheumatoid factor positive, yes, n (%)	170 (75.2)
Types of rheumatoid factor positive, yes, n (%)	
IgG	163 (72.1)
IgA	142 (62.8)
IgM	156 (69.0)
Rheumatoid factor, IU/mL, n (%)	
Normal (<16)	56 (24.8)
~100	36 (15.9)
~300	58 (25.7)
~600	37 (16.4)
>600	39 (17.3)
Glucose-6-phosphate isomerase (GPI), positive, yes, n (%)	20 (8.9)
Anti-keratin (AKA), positive, yes, n (%)	54 (23.9)
Anti-rheumatoid arthritis 33 (RA33), positive, yes, n (%)	12 (5.3)
Anti-cyclic citrullinated peptide (ACPA), positive, yes, n (%)	166 (73.5)
Serum ferritin, positive, yes, n (%)	68 (30.1)
Carcino-embryonic antigen, positive, yes, n (%)	7 (3.1)
Alpha fetal protein, positive, yes, n (%)	10 (4.4)
Antinuclear antibodies (ANA), positive, yes, n (%)	19 (8.4)
Anti-histone, positive, yes, n (%)	1 (0.4)
Anti-dsDNA, positive, yes, n (%)	7 (3.1)
Anti-U1RNP, positive, yes, n (%)	1 (0.4)
Anti-SSA, positive, yes, n (%)	2 (0.9)
Anti-Scl-70, positive, yes, n (%)	1 (0.4)

Comorbidity and lifestyle

Current smoking habit*, yes, n (%)	36 (15.9)
Current drinking habit*, yes, n (%)	15 (6.6)
Hypertension, yes, n (%)	51 (22.6)
Types of hypertension, n (%)	
primary	50 (22.1)
secondary	1 (0.4)
Grades of hypertension, n (%)	
1	3 (1.3)
2	23 (10.2)
3	25 (11.1)
Risk groups of hypertension, n (%)	
low risk	4 (1.8)
moderate risk	12 (5.3)
high risk	35 (15.5)
Not controlled hypertension, yes, n (%)	4 (1.8)
Pathoglycemia, yes, n (%)	32 (14.2)
Types of pathoglycemia, n (%)	
impaired glucose tolerance	2 (0.9)
type 2 diabetes mellitus	27 (11.9)
steroid diabetes	3 (1.3)
Anemia, yes, n (%)	32 (14.2)
Severities of anemia (Hb, g/L), n (%)	
mild (~90)	92 (40.7)
moderate (60~89)	19 (8.4)
severe (30~59)	2 (0.9)

*: active smoking or drinking within three months before the date of ECG-check.

BMI: body mass index; DAS: disease activity score; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; Ig: immunoglobulin; NSAIDs: non-steroidal anti-inflammatory drugs; bDMARDs: biological disease modifying antirheumatic drug; PPI: proton pump inhibitor; WBC: white blood cell; PLT: platelets.

1. Wildman RP, Gu D, Reynolds K, et al. Appropriate body mass index and waist circumference cutoffs for categorization of overweight and central adiposity among Chinese adults. *Am J Clin Nutr* 2004;80(5):1129-36. doi: 10.1093/ajcn/80.5.1129 [published Online First: 2004/11/09]

Supplementary Table 2 Follow-up information

Characteristics	
Demographic	
Gender, female, n (%)	67 (70.5)
Age, n (%)	
<40	3 (3.2)
~49	8 (8.4)
~59	32 (33.7)
~69	35 (36.8)
>=70	17 (17.9)
Follow-up period, months, median [IQR]	13.0 [12.0;22.0]
Disease-related	
DAS28-ESR, n (%)	
remission (<2.6 points)	6 (6.3)
mild (~3.2 points)	7 (7.4)
moderate (~5.1 points)	37 (38.9)
active (>5.1 points)	45 (47.4)
DAS28-ESR improvement*, n (%)	
good improvement	8 (8.51)
moderate improvement	40 (42.6)
no improvement	20 (21.3)
more active	26 (27.7)
DAS28-CRP, n (%)	
remission (<2.6 points)	11 (11.6)
mild (~3.2 points)	11 (11.6)
moderate (~5.1 points)	41 (43.2)
active (>5.1 points)	32 (33.7)
DAS28-CRP improvement*, n (%)	
good improvement	11 (11.7)
moderate improvement	34 (36.2)
no improvement	23 (24.5)
more active	26 (27.7)
CRP elevation, yes, n (%)	61 (64.2)
CRP, mg/L, n (%)	
<=6	34 (35.8)
~10	7 (7.37)
~20	19 (20.0)
~30	6 (6.3)
~50	14 (14.7)
>50	15 (15.8)
ESR elevation, yes, n (%)	70 (73.7)
ESR, n (%)	
~15(male) or ~20(female)	25 (26.3)

~30	15 (15.8)
~50	21 (22.1)
~70	12 (12.6)
~90	8 (8.42)
>90	14 (14.7)
Rheumatoid factor positive, yes, n (%)	69 (72.6)
Types of rheumatoid factor positive, yes, n (%)	
IgG	25 (69.4)
IgA	19 (52.8)
IgM	28 (77.8)
Rheumatoid factor, IU/mL, n (%)	
Normal (<16)	18 (18.9)
~100	32 (33.7)
~300	25 (26.3)
~600	13 (13.7)
~900	2 (2.1)
>900	5 (5.3)
Glucose-6-phosphate isomerase (GPI), positive, yes, n (%)	2 (3.1)
Anti-keratin (AKA), positive, yes, n (%)	19 (20.0)
Anti-rheumatoid arthritis 33 (RA33), positive, yes, n (%)	9 (13.8)
Anti-cyclic citrullinated peptide (ACPA), positive, yes, n (%)	66 (81.5)

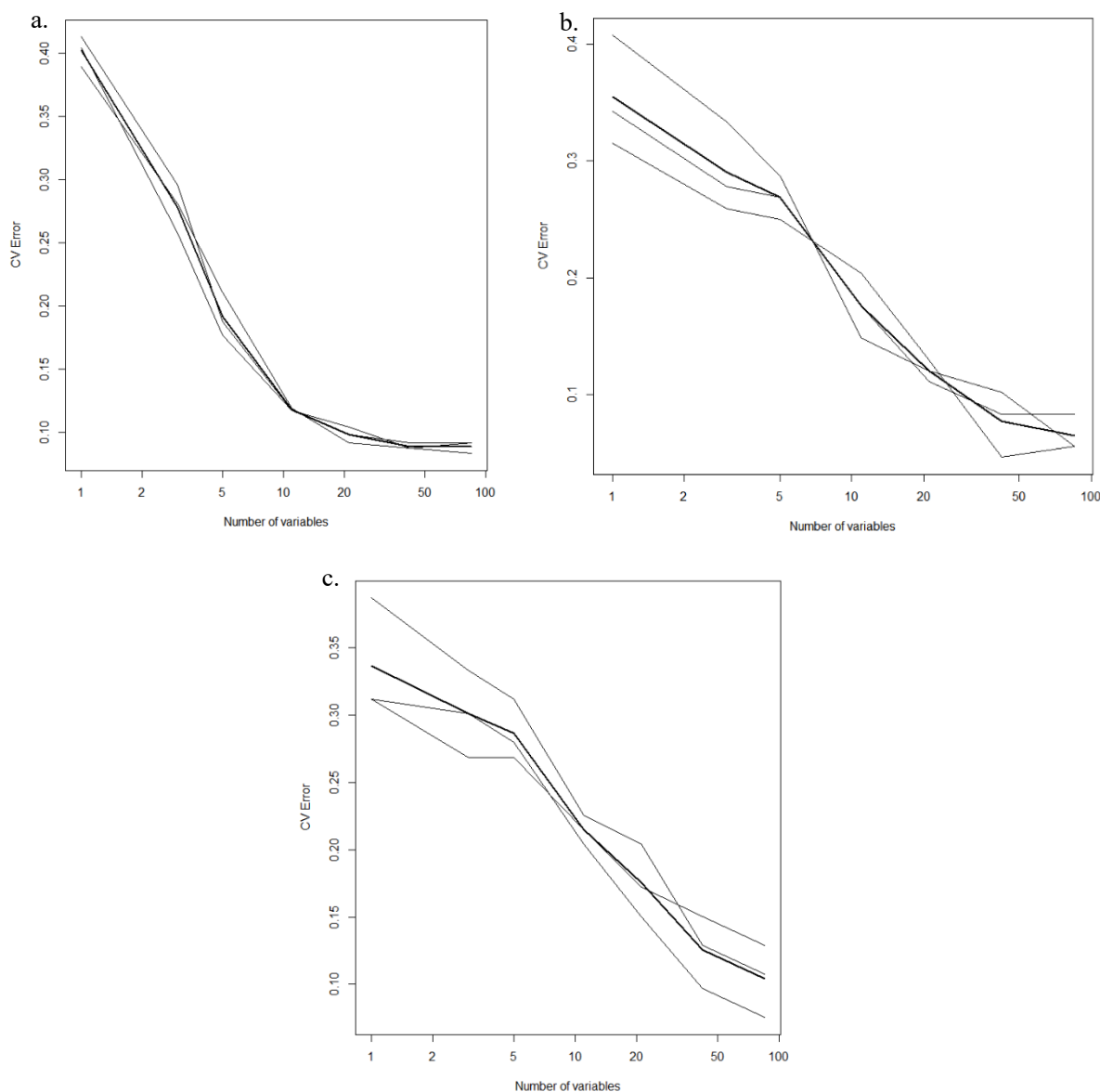
*: compare with the last time DAS28 evaluation. Good improvement, decrease>1.2; moderate improvement, 1.2<decrease<0.6; no improvement, decrease<0.6; more active, not decrease but increase. DAS: disease activity score; ESR: erythrocyte sedimentation rate; CRP:C-reactive protein; Ig: immunoglobulin

Supplementary Table 3 Models contribution in stacking models

Nonspecific ST-T changes				
Models	Estimate	Standard Error	z-value	<i>p</i>
RF	-11.0792	Supplementary Table 3 Models contribution in stacking models	-10.879	<0.001
ADA	-0.9513	Nonspecific ST- T changes	-2.344	0.019
NNET	1.5789	0.3609	4.375	<0.001
xGBTree	-0.5638	0.4471	-1.261	0.207
LASSO	-1.3170	0.4217	-3.123	0.002
Prolonged QTc interval				
RF	-5.7330	2.7886	-2.056	0.049
ADA	0.3388	0.7665	0.442	0.659
NNET	5.3643	1.2384	4.331	<0.001
xGBTree	-0.7056	0.6493	-1.087	0.277
LASSO	-9.4811	1.4642	-6.475	<0.001
Increased QRS-T angle				
RF	-14.8801	3.9641	-3.754	<0.001
ADA	-1.4253	0.6511	-2.189	0.029
NNET	2.8234	1.5938	1.771	0.076
xGBTree	4.0176	1.0196	3.941	<0.001
LASSO	-4.8088	1.4094	-3.412	<0.001

models with $p < 0.05$ would be involved in the stacking models.

After knocking out the model whose AUC is lower when models' correlations were greater than 75%, we performed model-stacking on the rest algorithms to train a stacked logistic mode. We adopted the algorithm with no significant contribution ($p>0.05$) for the stacked logistic models and re-performed the logistic-stacking. Next, we compare the stacked logistic model with the models built with a certain algorithm in AUC and screen the most suitable model. Then, we adopted the screened algorithms to filter the significant dependent variables to explain the outcome variables and screened the sensible factors.

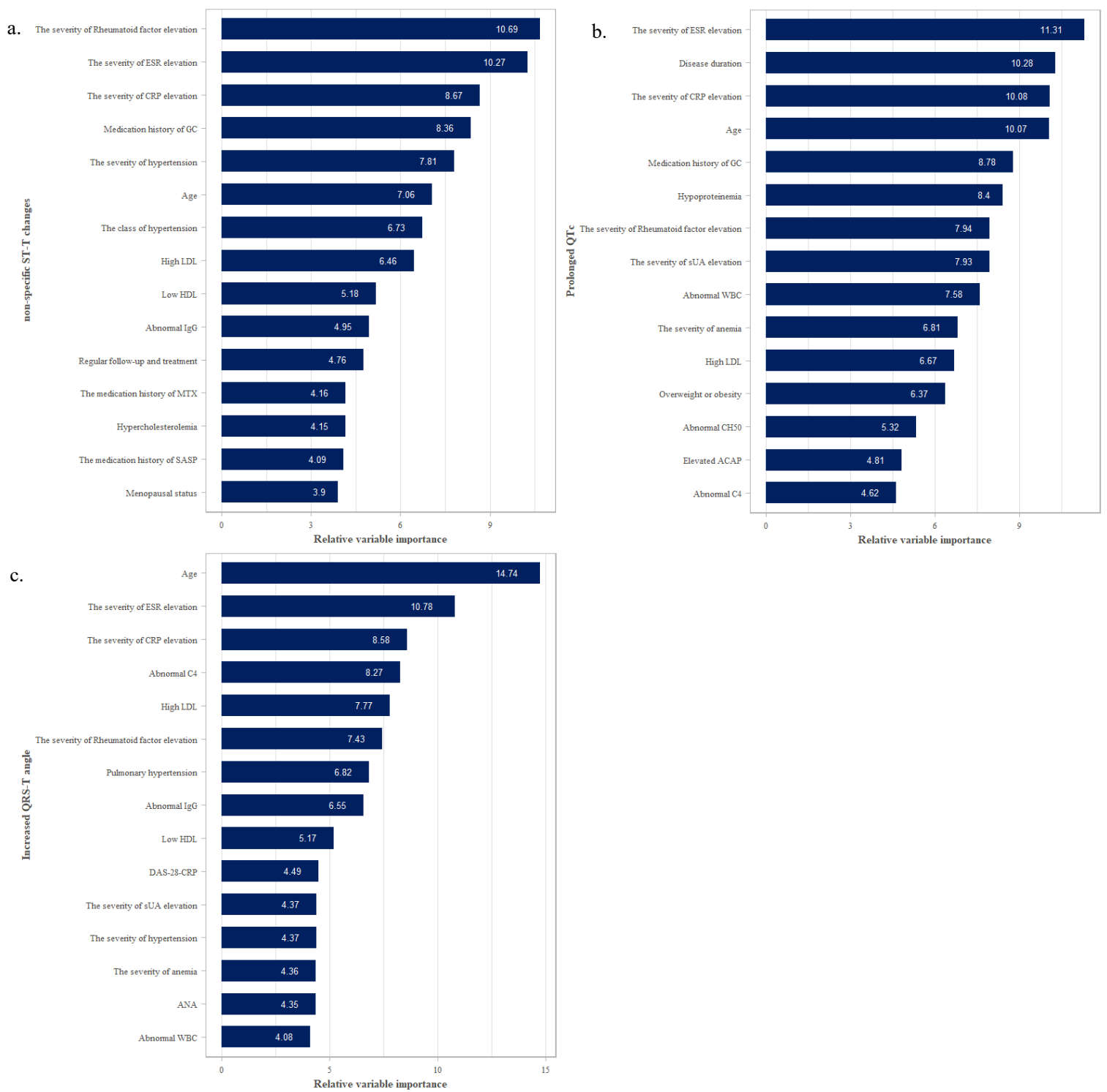


Supplementary Figure 1 The relationship between numbers of included variables and error rate during RF modeling procedure, after 5-folds, 3 times repeated cross validation. The bold line is the average error rate. a. nonspecific ST-T changes; b. prolonged QTc interval; c. increased QRS-T angle.

Supplementary Table 4 Parameters and performance of RF models

	Nonspecific ST-T changes	Prolonged QTc interval	Increased QRS-T angle
Parameters			
number of randomly sampled predictors	4	4	4
number of decision trees	500	400	400
Out-of-bag rate (%)	6.6	4.63	5.38
AUC (95%CI)*	0.894 (0.847, 0.936)	0.9565 (0.852, 0.995)	0.8718 (0.726, 0.957)
Precision	0.833	0.998	0.722
Recall rate	0.938	0.913	0.996
F1-measure	0.882	0.955	0.839
Brier's score	0.541	0.509	0.516

*: *calculated with bootstrap sampling (1000 times).*



Supplementary Figure 2 The top-15 important variables selected by three RF models.
a. nonspecific ST-T changes; b. prolonged QTc interval; c. increased QRS-T angle.

Supplementary Table 5 Crude HR of variables included in Cox regression

	HR (95% CI)	p
Nonspecific ST-T changes		
Gender		
Female	Ref.	
Male	0.88 (0.62 - 1.26)	0.486
Rheumatoid factor, IU/mL		
Normal (<16)	Ref.	
~100	1.08 (0.72 - 1.63)	0.696
~300	1.05 (0.68 - 1.63)	0.812
~600	1.22 (0.72 - 2.07)	0.465
~900	2.23 (1.19 - 4.2)	0.013
>900	3.12 (1.09 - 8.91)	0.034
CRP, mg/L		
<=6	Ref.	
~10	1.52 (0.93 - 2.51)	0.097
~20	0.62 (0.36 - 1.07)	0.087
~30	0.82 (0.37 - 1.81)	0.616
~40	1.23 (0.78 - 1.94)	0.365
~50	0.95 (0.56 - 1.62)	0.864
>50	0.96 (0.58 - 1.59)	0.865
ESR		
~15(male) or ~20(female)	Ref.	
~30	0.92 (0.59 - 1.45)	0.733
~50	0.46 (0.29 - 0.73)	0.001
~70	0.48 (0.27 - 0.85)	0.012
~90	0.43 (0.26 - 0.74)	0.002
>90	0.8 (0.48 - 1.33)	0.387
Period of GC usage, months		
No	Ref.	
~6	0.98 (0.62 - 1.54)	0.93
~12	0.59 (0.37 - 0.94)	0.026
~24	0.6 (0.4 - 0.9)	0.014
>24	0.06 (0.01 - 0.45)	0.006
Age		
<40	Ref.	
~49	13323785.78 (0 - Inf)	0.993
~59	7789340.43 (0 - Inf)	0.993
~69	11394438.75 (0 - Inf)	0.993
>=70	6403447.71 (0 - Inf)	0.993
Grades of hypertension		
No	Ref.	
1	2.1 (1.28 - 3.44)	0.003

2	0.73 (0.4 - 1.35)	0.32
3	0.23 (0.06 - 0.91)	0.037
Risk groups of hypertension		
low risk	1.86 (1.12 - 3.1)	0.017
moderate risk	1.08 (0.67 - 1.74)	0.739
high risk	0.33 (0.14 - 0.82)	0.016
Low high-density lipoprotein (HDL), mmol/L		
Normal	Ref.	
low risk (>1.55)	14128954.83 (0 - Inf)	0.991
average risk (1.03~1.55)	14038760.83 (0 - Inf)	0.991
High risk (<1.03)	6744016.21 (0 - Inf)	0.992
High low-density lipoprotein (LDL), mmol/L		
optimal (~2.59 mmol/L)	Ref.	
near optimal (-3.37)	0.79 (0.5 - 1.25)	0.316
borderline high (~4.12)	8.13 (2.87 - 23.03)	0
high (~4.90)	0 (0 - Inf)	0.993
very high (>4.90)	0.45 (0.06 - 3.23)	0.428
Prolonged QTc interval		
Gender		
Female	Ref.	
Male	0.53 (0.36 - 0.77)	0.001
Rheumatoid factor, IU/mL		
Normal (<16)	Ref.	
~100	1.65 (0.85 - 3.21)	0.14
~300	2.86 (1.69 - 4.85)	<0.001
~600	2.05 (1.08 - 3.91)	0.028
~900	4.39 (2.07 - 9.31)	<0.001
>900	0.68 (0.09 - 5.18)	0.714
CRP, mg/L		
<=6	Ref.	
~10	1.68 (1.04 - 2.7)	0.033
~20	0.85 (0.51 - 1.42)	0.537
~30	1.76 (1.01 - 3.09)	0.048
~40	1.19 (0.73 - 1.96)	0.485
~50	1.43 (0.84 - 2.43)	0.188
>50	1.03 (0.61 - 1.73)	0.911
ESR		
~15(male) or ~20(female)	Ref.	
~30	1.45 (0.81 - 2.6)	0.21
~50	2.44 (1.53 - 3.88)	<0.001
~70	2.34 (1.43 - 3.82)	0.001
~90	0.94 (0.52 - 1.73)	0.854
>90	0.41 (0.17 - 0.99)	0.048
Period of GC usage, months		

No	Ref.	
~6	1.23 (0.81 - 1.86)	0.33
~12	0.67 (0.45 - 1)	0.051
~24	0.35 (0.2 - 0.64)	<0.001
>24	0.19 (0.06 - 0.59)	0.004
Age		
<40	Ref.	
~49	0.98 (0.54 - 1.76)	0.942
~59	0.43 (0.24 - 0.79)	0.006
~69	0.79 (0.46 - 1.37)	0.405
>=70	0.34 (0.16 - 0.77)	0.009
sUA, $\mu\text{mol/L}$		
<420	Ref.	
~500	1.92 (1.28 - 2.88)	0.002
~600	1.94 (0.91 - 4.17)	0.088
~700	0 (0 - Inf)	0.992
High low-density lipoprotein (LDL), mmol/L		
optimal (~2.59 mmol/L)	Ref.	
near optimal (-3.37)	0.82 (0.51 - 1.34)	0.435
borderline high (~4.12)	11.62 (6.57 - 20.58)	<0.001
high (~4.90)	0.53 (0.27 - 1.05)	0.069
very high (>4.90)	0 (0 - Inf)	0.993
BMI, kg/m^2		
normal (18.5~23.9)	Ref.	
underweight (<18.5)	0.62 (0.4 - 0.95)	0.026
overweight (24~27.9)	0.06 (0.02 - 0.26)	<0.001
Obese (≥ 28)	0 (0 - Inf)	0.991
Hypoalbumin (<35g/L)		
No	Ref.	
Yes	0.53 (0.36 - 0.77)	0.001
Severities of anemia (Hb, g/L), n (%)		
No	Ref.	
mild (~90)	0.4 (0.27 - 0.58)	<0.001
moderate (60~89)	0.43 (0.25 - 0.74)	0.002
severe (30~59)	0.22 (0.03 - 1.64)	0.14
ACPA positive		
No	Ref.	
Yes	1.04 (0.76 - 1.43)	0.807
Increased QRS-T angle		
Gender		
Female	Ref.	
Male	1.08 (0.78 - 1.5)	0.624
Rheumatoid factor, IU/mL		
Normal (<16)	Ref.	

~100	1.31 (0.87 - 1.96)	0.198
~300	1.5 (1.04 - 2.18)	0.032
~600	1.21 (0.71 - 2.06)	0.494
~900	3.07 (1.77 - 5.3)	<0.001
>900	0.33 (0.05 - 2.41)	0.275
CRP, mg/L		
<=6	Ref.	
~10	1.77 (1.25 - 2.52)	0.001
~20	0.45 (0.26 - 0.77)	0.004
~30	0(0-Inf)	0.996
~40	0(0-Inf)	0.996
~50	0(0-Inf)	0.996
>50	0(0-Inf)	0.992
ESR		
~15(male) or ~20(female)	Ref.	
~30	1.55 (1.03 - 2.34)	0.034
~50	1.18 (0.79 - 1.77)	0.426
~70	0.46 (0.26 - 0.84)	0.011
~90	0 (0 - Inf)	0.994
>90	0 (0 - Inf)	0.993
Age		
<40	Ref.	
~49	1.05(0-Inf)	1
~59	1.02(0-Inf)	1
~69	372301658.3(3-Inf)	0.998
>=70	108328537.4(4-Inf)	0.998
Low high-density lipoprotein (HDL), mmol/L		
Normal	Ref.	
low risk (>1.55)	37554558.18(1-Inf)	0.993
average risk (1.03~1.55)	40287129.58(5-Inf)	0.993
High risk (<1.03)	13571722.69(6-Inf)	0.994
High low-density lipoprotein (LDL), mmol/L		
optimal (~2.59 mmol/L)	Ref.	
near optimal (-3.37)	0.72 (0.47 - 1.1)	0.127
borderline high (~4.12)	5.9 (3.56 - 9.78)	<0.001
high (~4.90)	0.04 (0.01 - 0.31)	0.002
very high (>4.90)	0 (0 - Inf)	0.992
Pulmonary arterial hypertension (PAH)		
normal	Ref.	
mild	0.05(0-0.39)	0.004
moderate	0(0-Inf)	0.995
severe	0(0-Inf)	0.995
Serum C4		
normal	Ref.	

decreased	0(0-Inf)	0.999
increased	0(0-Inf)	0.993
Serum immunoglobulin G (IgG), n (%)		
normal		
decreased	6.12(1-8.65)	<0.001
increased	0.74(7-1.35)	0.327

Variables would be selected to build a multivariate Cox regression when $p < 0.1$.