

**Supplement Table S1.** Experimental results of substituting values in the development of mathematical models.

No.	Age	Age group	Grade	Ki-67	Ki-67	p16 <sup>AS</sup>	p16 <sup>P/N</sup>	CTTN	CTTN	mRNA
				AS	P/N			AS	P/N	E6E7
1	49	3	normal	0	1	0	1	2	1	1
2	43	3	normal	0	1	0	1	0	1	1
3	57	4	normal	0	1	0	1	3	1	1
4	27	1	normal	0	1	0	1	3	1	1
5	49	3	normal	0	1	0	1	3	1	2
6	42	3	normal	0	1	0	1	3	1	2
7	44	3	normal	0	1	0	1	4	2	1
8	54	4	normal	0	1	0	1	5	2	2
9	43	3	normal	0	1	0	1	7	2	2
10	54	4	normal	0	1	0	1	5	2	2
11	51	4	normal	3	1	0	1	0	1	2
12	36	2	normal	3	1	0	1	3	1	2
13	36	2	normal	4	2	0	1	3	1	2
14	43	3	normal	4	2	0	1	0	1	2
15	57	4	normal	5	2	0	1	3	1	2
16	51	4	normal	4	2	0	1	6	2	2
17	38	2	normal	4	2	0	1	6	2	2
18	42	3	normal	4	2	0	1	6	2	2
19	35	2	normal	4	2	0	1	4	2	2
20	46	3	normal	5	2	0	1	5	2	2
21	48	3	LSIL	0	1	0	1	0	1	2
22	47	3	LSIL	0	1	0	1	0	1	2
23	20	1	LSIL	0	1	0	1	2	1	2
24	35	2	LSIL	0	1	2	1	6	2	1
25	49	3	LSIL	0	1	0	1	5	2	2
26	50	4	LSIL	0	1	0	1	4	2	2
27	61	5	LSIL	0	1	0	1	6	2	2
28	21	1	LSIL	0	1	0	1	7	2	2
29	48	3	LSIL	0	1	0	1	7	2	2

30	34	2	LSIL	0	1	0	1	4	2	2
31	36	2	LSIL	0	1	5	1	6	2	1
32	32	2	LSIL	0	1	2	1	6	2	2
33	54	4	LSIL	0	1	2	1	7	2	2
34	51	4	LSIL	0	1	2	1	6	2	2
35	34	2	LSIL	5	2	0	1	6	2	1
36	57	4	LSIL	0	1	5	1	6	2	2
37	84	5	LSIL	0	1	5	1	6	2	2
38	29	1	LSIL	4	2	0	1	4	2	2
39	23	1	LSIL	4	2	0	1	6	2	2
40	54	4	LSIL	5	2	0	1	6	2	2
41	24	1	LSIL	5	2	5	1	7	2	1
42	43	3	LSIL	4	2	4	1	4	2	2
43	39	2	LSIL	4	2	5	2	5	2	2
44	47	3	LSIL	5	2	5	1	6	2	2
45	51	4	LSIL	6	2	4	2	4	2	2
46	24	1	LSIL	6	2	4	2	6	2	2
47	35	2	HSIL	0	1	0	1	5	1	2
48	47	3	HSIL	0	1	5	1	4	2	2
49	51	4	HSIL	0	1	5	2	7	2	2
50	68	5	HSIL	6	2	7	2	2	1	2
51	55	4	HSIL	5	2	5	2	5	2	2
52	49	3	HSIL	5	2	5	2	5	2	2
53	51	4	HSIL	7	2	6	2	2	1	2
54	43	3	HSIL	5	2	6	2	7	2	2
55	61	5	HSIL	6	2	5	2	6	2	2
56	38	2	HSIL	6	2	5	2	6	2	2
57	47	3	HSIL	6	2	6	2	7	2	2
58	51	4	HSIL	6	2	6	2	7	2	2
59	32	2	HSIL	6	2	7	2	6	2	2
60	51	4	HSIL	6	2	7	2	7	2	2
61	39	2	HSIL	7	2	7	2	5	2	2
62	54	4	HSIL	7	2	7	2	7	2	2
63	34	2	HSIL	7	2	7	2	7	2	2

64	52	4	HSIL	7	2	7	2	7	2	2
65	33	2	HSIL	7	2	7	2	7	2	2
66	47	3	HSIL	7	2	7	2	7	2	2
67	47	3	HSIL	7	2	7	2	7	2	2
68	47	3	SCC	0	1	7	2	7	2	2
69	82	5	SCC	0	1	7	2	7	2	2
70	60	4	SCC	7	2	6	2	7	2	2
71	51	4	SCC	5	2	7	2	7	2	2
72	58	4	SCC	7	2	7	2	7	2	2
73	62	5	SCC	7	2	7	2	7	2	2
74	45	3	SCC	7	2	7	2	7	2	2
75	55	4	SCC	7	2	7	2	7	2	2

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P/N = positive or negative, AS = Allred scored, CTTN = cortactin

**Supplement Table S2.** The expected prediction value from development of mathematical models.

No.	Age	Age group	Grade	model 1	model 2	model 3	model 4	model 5
1	60	4	normal	1.15	0.384	0.211	1.065	0.1
2	49	3	normal	1.15	0.384	0.211	1.065	0.253
3	43	3	normal	1.15	0.384	0.211	1.065	0.253
4	51	4	normal	1.15	0.384	0.211	1.065	0.1
5	48	3	normal	1.15	0.384	0.211	1.065	0.253
6	45	3	normal	1.15	0.384	0.211	1.065	0.253
7	48	3	normal	1.15	0.384	0.211	1.065	0.253
8	43	3	normal	1.15	0.384	0.211	1.065	0.253
9	48	3	normal	1.15	0.384	0.211	1.065	0.253
10	40	2	normal	1.15	0.384	0.211	1.065	0.406
11	55	4	normal	1.15	0.384	0.211	1.065	0.1
12	24	1	normal	1.15	0.384	0.211	1.065	0.559
13	50	4	normal	1.15	0.384	0.211	1.065	0.1
14	42	3	normal	1.15	0.384	0.211	1.065	0.253
15	33	2	normal	1.15	0.384	0.211	1.065	0.406
16	49	3	normal	1.15	0.384	0.729	0.785	0.77
17	43	3	normal	1.15	0.384	0.729	0.785	0.77
18	57	4	normal	1.15	0.384	0.729	0.785	0.617
19	27	1	normal	1.15	0.384	0.729	0.785	1.076
20	38	2	normal	1.15	0.954	0.768	1.595	0.945
21	42	3	normal	1.15	0.954	0.768	1.595	0.792
22	61	5	normal	1.15	0.954	0.768	1.595	0.486
23	50	4	normal	1.15	0.954	0.768	1.595	0.639
24	63	5	normal	1.15	0.954	0.768	1.595	0.486
25	50	4	normal	1.15	0.954	0.768	1.595	0.639
26	52	4	normal	1.15	0.954	0.768	1.595	0.639
27	47	3	normal	1.15	0.954	0.768	1.595	0.792
28	41	3	normal	2.226	1.452	1.191	2.613	1.054
29	33	2	normal	2.226	1.452	1.191	2.613	1.207

30	42	3	normal	2.226	1.452	1.191	2.613	1.054
31	50	4	normal	2.226	1.452	1.191	2.613	0.901
32	49	3	normal	1.15	0.384	1.247	0.505	1.287
33	42	3	normal	1.15	0.384	1.247	0.505	1.287
34	44	3	normal	1.15	0.954	1.286	1.315	1.309
35	44	3	normal	2.495	1.719	1.436	3	1.441
36	46	3	normal	2.226	2.022	1.748	3.143	1.593
37	48	3	normal	2.226	2.022	1.748	3.143	1.593
38	54	4	normal	1.15	0.954	1.804	1.035	1.673
39	43	3	normal	1.15	0.954	1.804	1.035	1.826
40	54	4	normal	1.15	0.954	1.804	1.035	1.673
41	51	4	normal	1.957	1.185	1.982	1.666	2.295
42	36	2	normal	1.957	1.185	1.982	1.666	2.601
43	55	4	normal	2.495	2.289	1.993	3.53	1.827
44	63	5	normal	2.495	2.289	1.993	3.53	1.674
45	49	3	normal	2.495	2.289	1.993	3.53	1.98
46	46	3	normal	2.495	2.289	1.993	3.53	1.98
47	36	2	normal	2.226	1.452	2.227	2.053	2.241
48	43	3	normal	2.226	1.452	2.227	2.053	2.088
49	52	4	normal	2.764	2.556	2.238	3.917	2.214
50	57	4	normal	2.495	1.719	2.472	2.44	2.322
51	51	4	normal	2.226	2.022	2.784	2.583	2.474
52	38	2	normal	2.226	2.022	2.784	2.583	2.78
53	42	3	normal	2.226	2.022	2.784	2.583	2.627
54	35	2	normal	2.226	2.022	2.784	2.583	2.78
55	46	3	normal	2.495	2.289	3.029	2.97	3.014
56	39	2	LSIL	1.15	0.954	0.768	1.595	0.945
57	37	2	LSIL	1.15	0.954	0.768	1.595	0.945
58	48	3	LSIL	1.15	0.384	1.247	0.505	1.287
59	47	3	LSIL	1.15	0.384	1.247	0.505	1.287
60	20	1	LSIL	1.15	0.384	1.247	0.505	1.593
61	42	3	LSIL	1.957	1.755	1.503	2.756	1.953
62	35	2	LSIL	1.544	0.954	1.59	1.599	1.74
63	46	3	LSIL	2.226	2.022	1.748	3.143	1.593

64	49	3	LSIL	1.15	0.954	1.804	1.035	1.826
65	51	4	LSIL	1.15	0.954	0.768	1.595	0.639
66	50	4	LSIL	1.15	0.954	1.804	1.035	1.673
67	61	5	LSIL	1.15	0.954	1.804	1.035	1.52
68	21	1	LSIL	1.15	0.954	1.804	1.035	2.132
69	48	3	LSIL	1.15	0.954	1.804	1.035	1.826
70	34	2	LSIL	1.15	0.954	1.804	1.035	1.979
71	36	2	LSIL	2.135	0.954	2.046	2.025	2.157
72	32	2	LSIL	1.544	0.954	2.108	1.319	2.257
73	54	4	LSIL	1.544	0.954	2.108	1.319	1.951
74	51	4	LSIL	1.544	0.954	2.108	1.319	1.951
75	34	2	LSIL	2.495	2.289	2.511	3.25	2.65
76	57	4	LSIL	2.135	0.954	2.564	1.745	2.368
77	84	5	LSIL	2.135	0.954	2.564	1.745	2.215
78	29	1	LSIL	2.226	2.022	2.784	2.583	2.933
79	23	1	LSIL	2.226	2.022	2.784	2.583	2.933
80	54	4	LSIL	2.495	2.289	3.029	2.97	2.861
81	24	1	LSIL	3.48	2.289	3.271	3.96	3.498
82	43	3	LSIL	3.014	2.022	3.392	3.151	3.183
83	39	2	LSIL	3.211	2.194	3.544	3.293	3.475
84	47	3	LSIL	3.48	2.289	3.789	3.68	3.709
85	51	4	LSIL	3.552	2.728	3.882	3.925	3.804
86	24	1	LSIL	3.552	2.728	3.882	3.925	4.263
87	54	4	HSIL	1.15	0.954	0.768	1.595	0.639
88	52	4	HSIL	1.15	0.954	0.768	1.595	0.639
89	35	2	HSIL	1.15	0.384	1.247	0.505	1.44
90	68	5	HSIL	1.957	1.755	1.503	2.756	1.647
91	66	5	HSIL	2.495	2.289	1.993	3.53	1.674
92	34	2	HSIL	2.495	2.289	1.993	3.53	2.133
93	56	4	HSIL	2.495	2.289	1.993	3.53	1.827
94	26	1	HSIL	3.408	1.624	2.103	3.465	2.194
95	44	3	HSIL	2.764	2.556	2.238	3.917	2.367
96	47	3	HSIL	2.135	0.954	2.564	1.745	2.521
97	51	4	HSIL	2.135	1.126	2.564	1.745	2.368

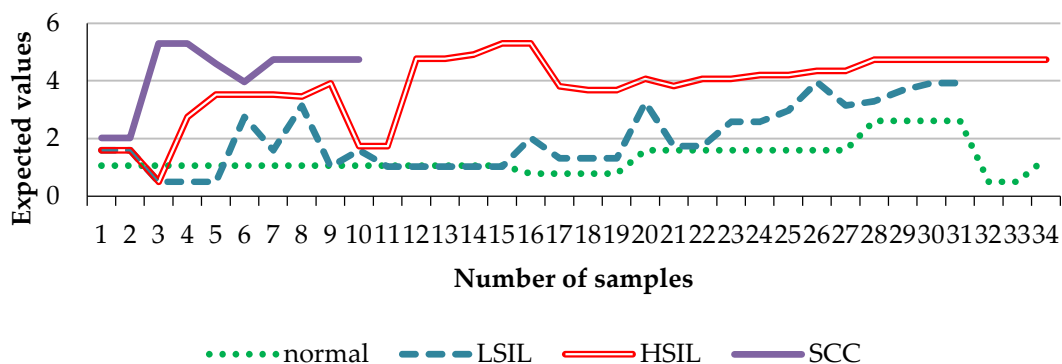
98	31	2	HSIL	4.412	2.425	2.99	4.768	3.341
99	33	2	HSIL	4.412	2.425	2.99	4.768	3.341
100	38	2	HSIL	4.143	2.728	3.302	4.911	3.493
101	28	1	HSIL	4.412	2.995	3.547	5.298	4.033
102	39	2	HSIL	4.412	2.995	3.547	5.298	3.88
103	68	5	HSIL	4.143	2.158	3.781	3.821	3.529
104	55	4	HSIL	3.48	2.461	3.789	3.68	3.556
105	49	3	HSIL	3.48	2.461	3.789	3.68	3.709
106	51	4	HSIL	4.215	2.425	3.874	4.066	3.93
107	43	3	HSIL	3.677	2.461	3.941	3.822	3.848
108	61	5	HSIL	3.749	2.728	4.034	4.067	3.79
109	38	2	HSIL	3.749	2.728	4.034	4.067	4.249
110	47	3	HSIL	3.946	2.728	4.186	4.209	4.235
111	51	4	HSIL	3.946	2.728	4.186	4.209	4.082
112	32	2	HSIL	4.143	2.728	4.338	4.351	4.527
113	51	4	HSIL	4.143	2.728	4.338	4.351	4.221
114	39	2	HSIL	4.412	2.995	4.583	4.738	4.914
115	54	4	HSIL	4.412	2.995	4.583	4.738	4.608
116	34	2	HSIL	4.412	2.995	4.583	4.738	4.914
117	52	4	HSIL	4.412	2.995	4.583	4.738	4.608
118	33	2	HSIL	4.412	2.995	4.583	4.738	4.914
119	47	3	HSIL	4.412	2.995	4.583	4.738	4.761
120	47	3	HSIL	4.412	2.995	4.583	4.738	4.761
121	47	3	SCC	2.529	1.126	2.868	2.029	2.799
122	82	5	SCC	2.529	1.126	2.868	2.029	2.493
123	34	2	SCC	4.412	2.995	3.547	5.298	3.88
124	60	4	SCC	4.412	2.995	3.547	5.298	3.574
125	60	4	SCC	4.215	2.995	4.431	4.596	4.469
126	51	4	SCC	3.874	2.461	4.093	3.964	3.834
127	58	4	SCC	4.412	2.995	4.583	4.738	4.608
128	62	5	SCC	4.412	2.995	4.583	4.738	4.455
129	45	3	SCC	4.412	2.995	4.583	4.738	4.761
130	55	4	SCC	4.412	2.995	4.583	4.738	4.608

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**Supplement Table S3.** Sensitivity, specificity, PPV and NPV of pathological grades analyzed by models 1 to 5 in the test sample set.

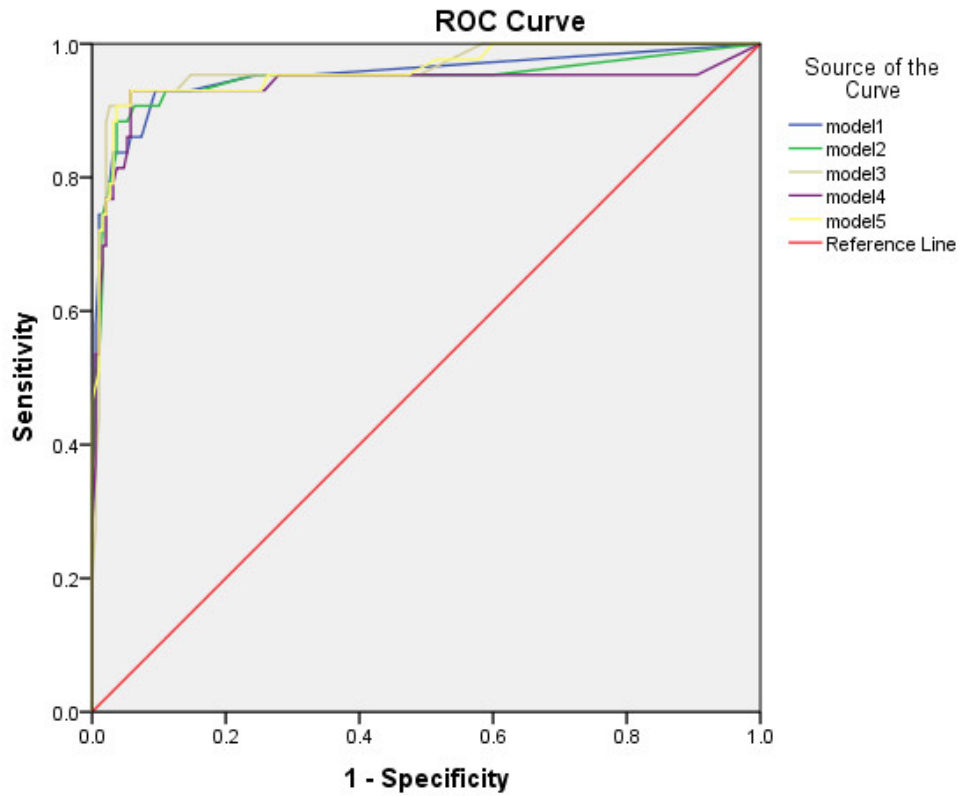
Tested sample set					
LSIL group (Normal+LSIL) <i>vs</i> HSIL group (HSIL+SCC)					
	Sensitivity	Specificity	PPV	NPV	OR
Model 1	86	93	73	97	77.52
Model 2	91	90	67	98	87.75
Model 3	91	96	85	98	254.89
Model 4	93	91	69	98	127.40
Model 5	91	96	83	98	221.81

PPV = Positive predictive value, NPV = Negative predictive value, OR = odds ratio



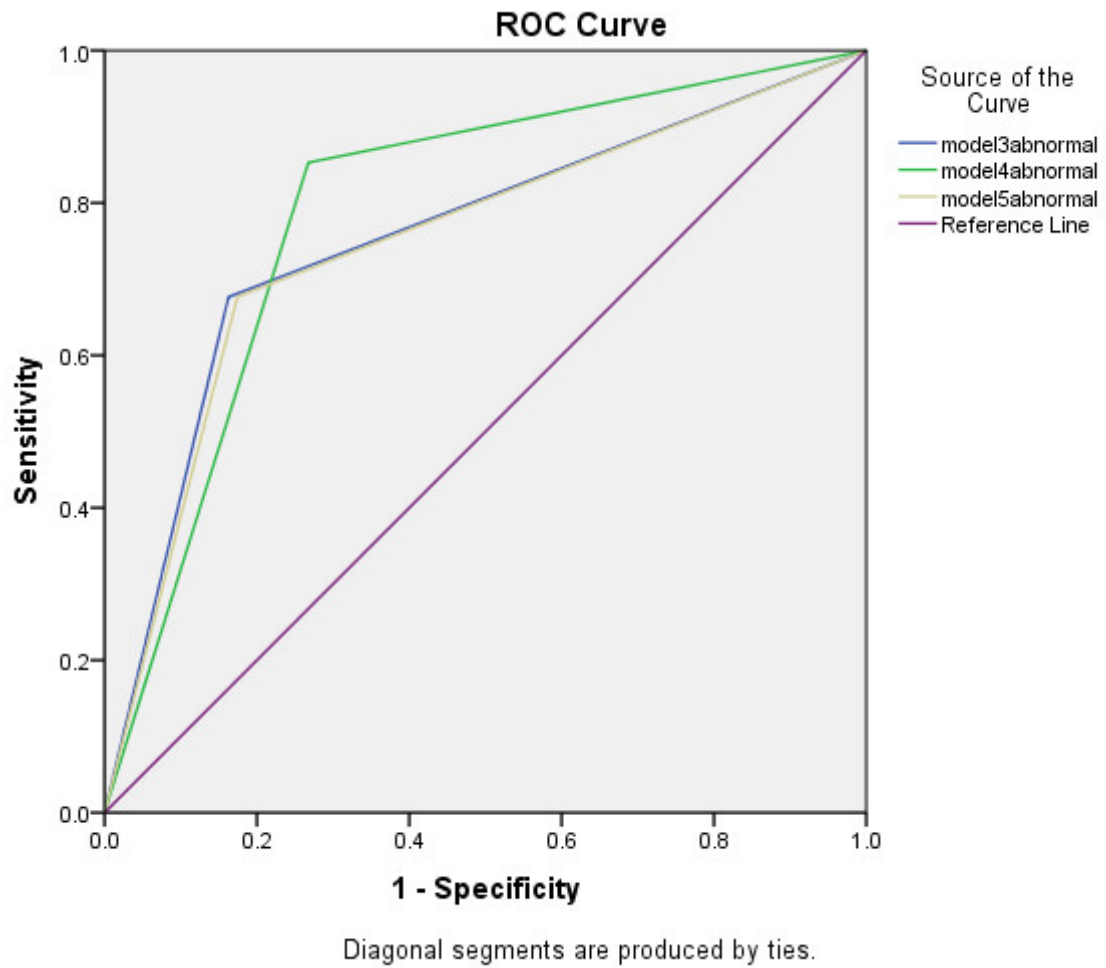
**Supplement Figure S1.** Means of the expected values from the linear regression models and clinical pathological grades (each sample) of confirmed sample sets.



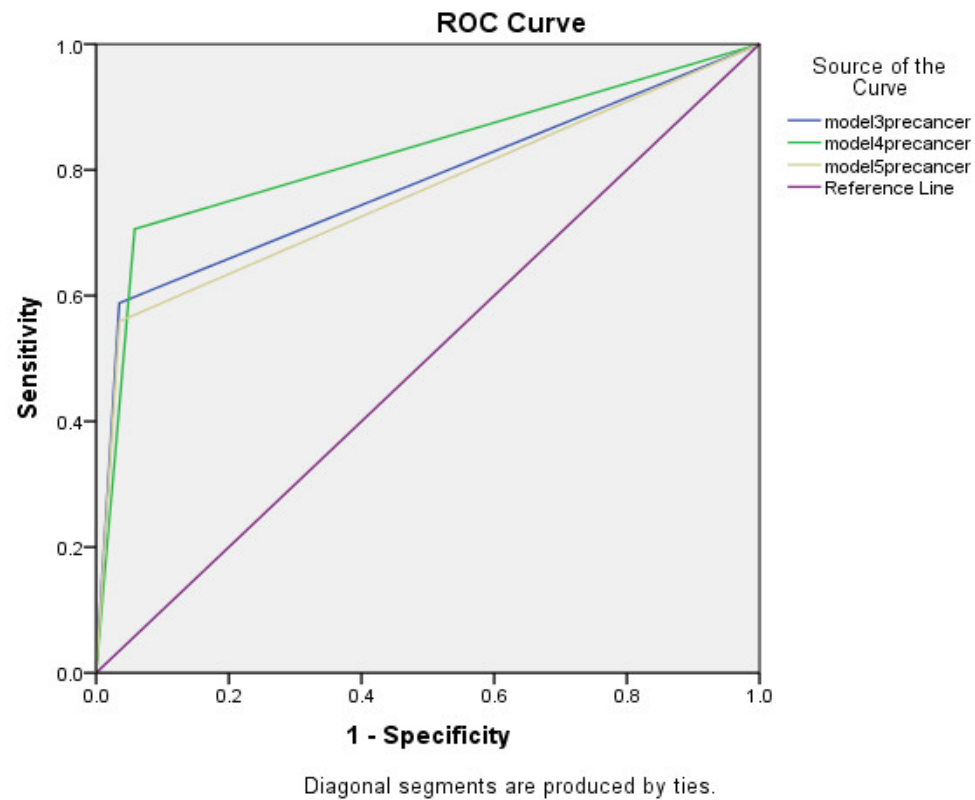


Diagonal segments are produced by ties.

**Supplement Figure S2.** ROC curves and AUCs when comparing sensitivity and specificity of models 1 to 5 between normal+LSIL and HSIL+SCC in the test sample set. AUCs of models 1 to 5 were 0.953, 0.946, 0.962, 0.937 and 0.960, respectively ( $P=0.000$ ).



**Supplement Figure S3.** ROC curves and AUC when comparing sensitivity and specificity of models 3 to 5 between normal and LSIL+HSIL in a confirmed sample set. AUCs of these models were 0.757, 0.793, and 0.751, respectively ( $P=0.000$ ) to predict risk biomolecules.



**Supplement Figure S4.** ROC curves and AUCs when comparing sensitivity and specificity of models 3 to 5 between normal+LSIL and HSIL in a confirmed sample set. AUCs of these model were 0.777, 0.824 and 0.762, respectively ( $P=0.000$ ) to predict precancerous lesions.

