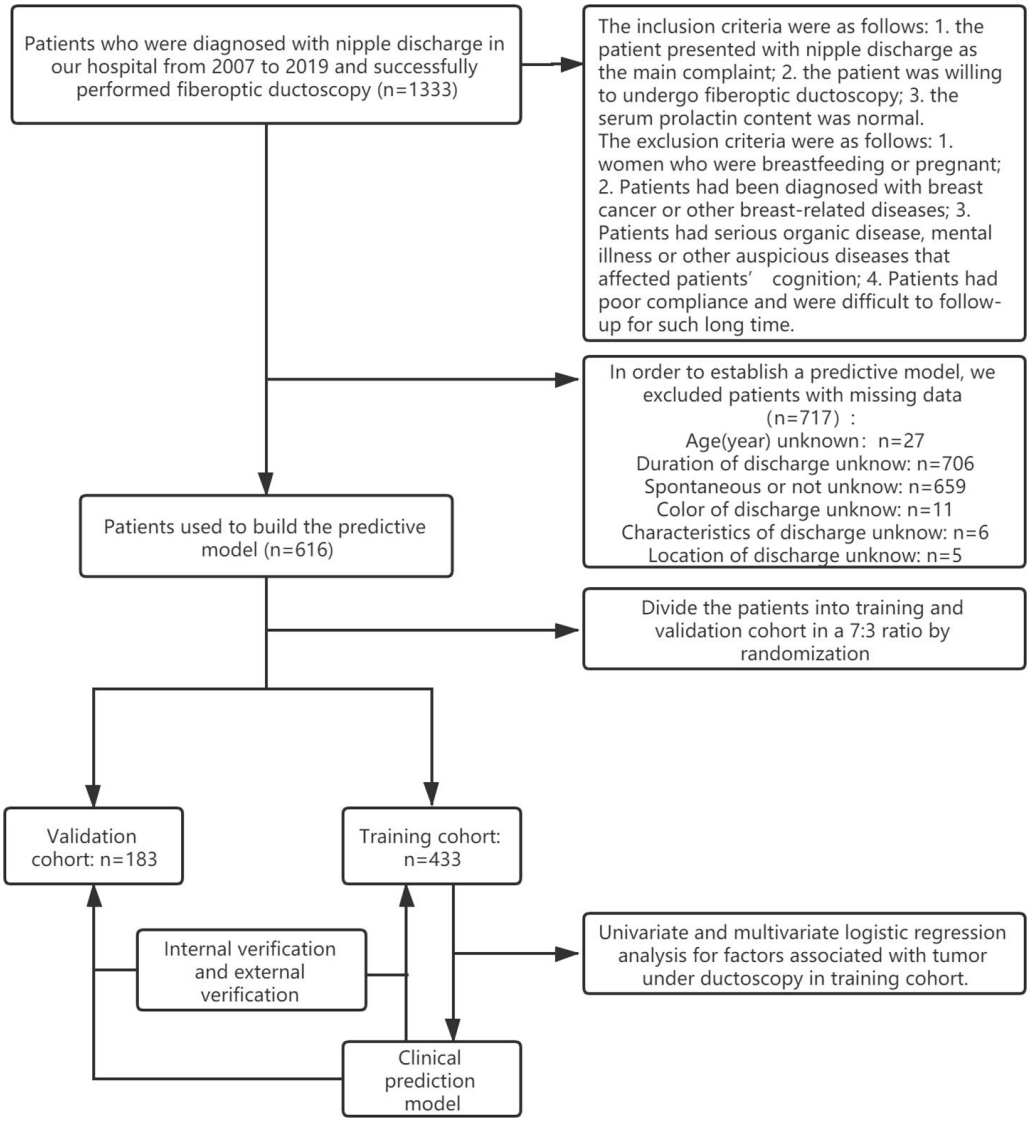
Supplemental Figure 1. The flowchart of the study.



Supplemental table1. Bonferroni adjustment.

Factors		*p*-value	Bonferroni adjustment of *p*-values
Age（year）			0.002
	<=20 vs. 21-30	1.000	
	<=20 vs. 31-40	1.000	
	<=20 vs. 41-50	1.000	
	<=20 vs. 51-60	1.000	
	<=20 vs. 61-70	0.914	
	<=20 vs. >70	0.516	
	21-30 vs. 31-40	0.266	
	21-30 vs. 41-50	0.015	
	21-30 vs. 51-60	0.002	
	21-30 vs. 61-70	0.001	
	21-30 vs. >70	0.001	
	31-40 vs. 41-50	0.071	
	31-40 vs. 51-60	0.008	
	31-40 vs. 61-70	0.006	
	31-40 vs. >70	0.003	
	41-50 vs. 51-60	0.158	
	41-50 vs. 61-70	0.059	
	41-50 vs. >70	0.016	
	51-60 vs. 61-70	0.410	
	51-60 vs. >70	0.079	
	61-70 vs. >70	0.247	
Duration of discharge			0.008
	Days vs. Weeks	0.083	
	Days vs. Months	0.024	
	Days vs. Years	0.144	
	Weeks vs. Months	0.669	
	Weeks vs. Years	0.600	
	Months vs. Years	0.251	
Color of discharge			0.008
	Red vs. Yellow	<0.001	
	Red vs. White or colorless	<0.001	
	Yellow vs. White or colorless	<0.001	
Characteristics of discharge			0.005
	Watery vs. Bloody	<0.001	
	Watery vs. Serosity	0.002	
	Watery vs. Milky	0.003	
	Watery vs. Soild	1.000	
	Bloody vs. Serosity	<0.001	

Bloody vs. Milky	<0.001
Bloody vs. Soild	0.027
Serosity vs. Milky	<0.001
Serosity vs. Soild	0.406
Milky vs. Soild	-

Supplemental table 2. Univariate binary logistics regression analysis of clinical factors with the diagnosis of tumor or no tumor identified by ductoscopy.

Factors	Tumor vs. no tumor		*p*-value
	OR	95% CI	
Age(year)			
≤20	0.31	0.04-2.35	0.256
21-30	0.20	0.07-0.55	0.002
31-40	0.25	0.09-0.66	0.006
41-50	0.32	0.12-0.85	0.022
51-60	0.41	0.15-1.14	0.086
61-70	0.53	0.18-1.57	0.251
＞70	Ref		
Duration of discharge			
Years	1.54	0.86-2.74	0.146
Months	1.92	1.09-3.40	0.025
Weeks	1.74	0.93-3.26	0.084
Days	Ref		
Side of discharge			
Unilateral	2.99	2.00-4.47	<0.001
Bilateral	Ref		
Location of discharge			
Single duct	3.48	2.45-4.95	<0.001
Multiple ducts	Ref		
Spontaneous or not			
Spontaneous	2.41	1.75-3.32	<0.001
Nonspontaneous	Ref		
Color of discharge			
Red	12.29	8.43-17.92	<0.001
Yellow	4.75	3.31-6.81	<0.001
White or colorless	Ref		
Characteristics of discharge			
Watery	1.56	0.18-13.70	0.689
Bloody	10.07	1.20-84.58	0.034
Serosity	3.48	0.42-29.03	0.250
Milky	0.44	0.05-4.12	0.472
Solid	Ref		
Ductal wall			
Smooth	8.03	5.88-10.96	<0.001
Rough	Ref		

Supplemental table 3. Comparison of breast ductoscopy diagnosis and pathological diagnosis.

	Pathological diagnosis	
Ductoscopy diagnosis	Tumor	No tumor
Tumor	236	20
No tumor	33	13

Supplemental table 4. Comparison of breast ductoscopy diagnosis and ultrasound diagnosis.

	Ultrasonography	
Ductoscopy diagnosis	Tumor	No tumor
Tumor	122	93
No tumor	42	15

Supplemental table 5. Relationship between the diagnosis of benign or malignant tumor identified by pathology and the clinical factors.

Factors	N				χ2	*p*-value
	Benign	%	Malignant or borderline	%		
Single or multiple tumors					3.529	0.060
Single	200	85.11%	14	66.67%		
Multiple	35	14.89%	7	33.33%		
blank	32		14			
Location in ducts					8.088	0.062
Primary duct	111	47.64%	8	40.00%		
Secondary duct	66	28.33%	4	20.00%		
Level 3 duct	36	15.45%	2	10.00%		
Level 4 duct	6	2.58%	2	10.00%		
Multistage ducts	14	6.01%	4	20.00%		
blank	34		15			
Distance from nipple					6.111	1.127
≤1cm	7	4.96%	0	0.00%		
1-3cm	83	58.87%	6	54.55%		
3-5cm	51	36.17%	4	36.36%		
＞5cm	0	0.00%	1	9.09%		
blank	126		24			
Color of tumor					0.635	0.915
Red	64	29.63%	5	27.78%		
Yellow	100	46.30%	8	44.44%		
White	9	4.17%	1	5.56%		
Mixed color	43	19.91%	4	22.22%		
blank	51		17			
Shape of tumor					1.404	0.720
Spherical	77	42.08%	9	52.94%		
Irregular	46	25.14%	4	23.53%		
Lobulated	30	16.39%	1	5.88%		
Strip	30	16.39%	3	17.65%		
blank	84		18			

Supplemental table 6. Baseline data of patients with malignant or borderline tumor.

Factors	N	%	Valid%[a]
Age(year)			
≤20	0	0.00	0.00
21-30	2	5.71	5.71
31-40	8	22.86	22.86
41-50	14	40.00	40.00
51-60	4	11.43	11.43
61-70	3	8.57	8.57
＞70	4	11.43	11.43
Blank	0	0.00	
Duration of discharge			
Days	2	5.71	11.76
Weeks	2	5.71	11.76
Months	10	28.57	58.82
Years	3	8.57	17.65
Blank	18	51.43	
Side of discharge			
Unilateral	35	100.00	100.00
Bilateral	0	0.00	0.00
Blank	0	0.00	
Location of discharge			
Single duct	33	94.29	94.29
Multiple ducts	2	5.71	5.71
Blank	0	0.00	
Spontaneous or not			
Nonspontaneous	8	22.86	47.06
Spontaneous	9	25.71	52.94
Blank	18	51.43	
Color of discharge			
Red	20	57.14	57.14
Yellow	13	37.14	37.14
White or colorless	2	5.71	5.71
Blank	0	0.00	
Characteristics of discharge			
Watery	1	2.86	2.86
Bloody	18	51.43	51.43
Serosity	16	45.71	45.71
Milky	0	0.00	0.00
Solid	0	0.00	0.00
Blank	0	0.00	

Ductal wall			
Smooth	23	65.71%	67.65%
Rough	11	31.43%	32.35%
Blank	1	2.86%	
Single or multiple tumors			
Single	14	40.00%	66.67%
Multiple	7	20.00%	33.33%
blank	14	40.00%	
Location in ducts			
Level 1 duct	8	22.86%	40.00%
Level 2 duct	4	11.43%	20.00%
Level 3 duct	2	5.71%	10.00%
Level 4 duct	2	5.71%	10.00%
Multistage ducts	4	11.43%	20.00%
blank	15	42.86%	
Distance from nipple			
≤1cm	0	0.00%	0.00%
1-3cm	6	17.14%	54.55%
3-5cm	4	11.43%	36.36%
＞5cm	1	2.86%	9.09%
blank	24	68.57%	
Color of tumor			
Red	5	14.29%	27.78%
Yellow	8	22.86%	44.44%
White	1	2.86%	5.56%
Mixed color	4	11.43%	22.22%
blank	17	48.57%	
Shape of tumor			
Spherical	9	25.71%	52.94%
Irregular	4	11.43%	23.53%
Lobulated	1	2.86%	5.88%
Strip	3	8.57%	17.65%
blank	18	51.43%	
ER			
+	7	20.00%	21.88%
++	11	31.43%	34.38%
+++	10	28.57%	31.25%
-	4	11.43%	12.50%
blank	3	8.57%	
PR			
+	10	28.57%	31.25%
++	8	22.86%	25.00%

+++	6	17.14%	18.75%
-	8	22.86%	25.00%
blank	3	8.57%	
HER2			
+	6	17.14%	19.35%
++	2	5.71%	6.45%
+++	6	17.14%	19.35%
-	17	48.57%	54.84%
blank	4	11.43%	
Ki67			
＜15%	20	57.14%	66.67%
15%-30%	3	8.57%	10.00%
＞30%	7	20.00%	23.33%
blank	5	14.29%	
Types of cancer			
Atypical hyperplasia	9	25.71%	25.71%
CIS	15	42.86%	42.86%
Invasive carcinoma	6	17.14%	17.14%
Special type carcinoma	3	8.57%	8.57%
Mixed carcinoma	2	5.71%	5.71%
blank	0	0.00%	
Operation method			
Breast conserving surgery	9	25.71%	25.71%
Mastectomy	26	74.29%	74.29%
blank	0	0.00%	

a. Percentages excluding "Blank".

Supplemental table 7.Comparison of the descriptive characteristics between the training cohort and the validation cohort.

Factors	N				*p*-value
	Training	%	Validation	%	
Age(year)					0.201
≤44	260	60.0	99	54.1	
>44	173	40.0	84	45.9	
Side of discharge					0.708
Unilateral	378	87.3	157	85.8	
Bilateral	55	12.7	26	14.2	
Spontaneous or not					1.000
Nonspontaneous	279	64.4	118	64.5	
Spontaneous	154	35.6	65	35.5	
Duration of discharge					0.996
Days	50	11.5	21	11.5	
Weeks	79	18.2	33	18.0	
Months	159	36.7	69	37.7	
Years	145	33.5	60	32.8	
Color of discharge					0.918
Non-red	297	68.6	127	69.4	
Red	136	31.4	56	30.6	
Characteristics of discharge					0.983
Non-bloody	312	72.1	131	71.6	
Bloody	121	27.9	52	28.4	
Location of discharge					0.565
Multiple ducts	66	15.2	32	17.5	
Single duct	367	84.8	151	82.5	
Tumor					0.194
No tumor	265	61.2	101	55.2	
Tumor	168	38.8	82	44.8	

Supplemental Table 8. Collinearity Statistics

Factors	Tolerance	VIF
Age_year	0.986	1.015
Side_of_discharge	0.188	5.325
Spontaneous_or_not	0.964	1.037
Duration_of_discharge	0.927	1.079
Color_of_discharge	0.303	3.306
Characteristics_of_discharge	0.296	3.376
Location_of_discharge	0.187	5.348