

Table S1 Causes of MPEs

Causes of MPEs	MPE (n=168)	Cytology-positive MPE (n=128)	Cytology-negative/suspected MPE (n=40)
Lung cancer	114 (67.8)	95 (74.2)	19 (47.5)
Breast cancer	11 (6.5)	10 (7.8)	1 (2.5)
Ovarian cancer	9 (5.4)	6 (4.7)	3 (7.5)
Colorectal cancer	7 (4.2)	6 (4.7)	1 (2.5)
Lymphoma	6 (3.6)	3 (2.3)	3 (7.5)
Mesothelioma	12 (7.1)	3 (2.3)	9 (22.5)
gastric cancer	4 (2.4)	3 (2.3)	1 (2.5)
Other cancers	5 (3.0)	2 (1.6)	3 (7.5)

MPE, malignant pleural effusion.

Table S2 The levels of tumor markers in cytology-positive MPE and cytology-negative/suspected MPE cases

Parameters	Cytology-positive MPE (n=128)	Cytology-negative/suspected MPE (n=40)	P value
Serum CEA (ng/mL)	8.59 (2.58, 33.53)	2.81 (1.80, 13.88)	0.055
Serum CA15-3 (U/mL)	17.70 (10.80, 35.28)	14.20 (9.43, 33.25)	0.23
Serum CA19-9 (U/mL)	20.40 (8.30, 88.40)	15.55 (5.35, 51.27)	0.25
Serum CA125 (U/mL)	142.75 (50.02, 231.18)	83.35 (29.15, 303.73)	0.55
Serum CYFRA21-1 (ng/mL)	4.55 (3.04, 9.66)	4.67 (2.92, 10.24)	0.97
Serum NSE (ng/mL)	15.55 (12.07, 20.83)	15.20 (12.38, 21.90)	0.86
Serum SCCA (ng/mL)	0.90 (0.70, 1.30)	0.80 (0.57, 1.20)	0.18
Effusion CEA (ng/mL)	81.00 (4.65, 565.58)	3.60 (1.10, 108.43)	0.004
Effusion CA15-3 (U/mL)	19.20 (7.50, 92.00)	19.35 (8.07, 55.73)	0.64
Effusion CA19-9 (U/mL)	12.00 (2.80, 184.30)	7.30 (2.17, 89.08)	0.26
Effusion CA125 (U/mL)	1,066.00 (403.68, 1,750.75)	713.45 (297.20, 1,312.00)	0.11
Effusion/serum CEA	3.85 (0.92, 21.04)	0.86 (0.56, 4.50)	0.001

Data are presented as median (IQR). CA, carbohydrate antigen; CEA, carcinoembryonic antigen; CYFRA21-1, cytokeratin 19 fragment; IQR, interquartile range; MPE, malignant pleural effusion; NSE, neuron-specific enolase; SCCA, squamous cell carcinoma antigen.

Table S3 Diagnostic performance of tumor markers for cytology-positive MPE and cytology-negative/suspected MPE

Parameters	Cytology-positive MPE				Cytology-negative/suspected MPE			
	Cut-off	AUC	Sensitivity (%)	Specificity (%)	Cut-off	AUC	Sensitivity (%)	Specificity (%)
Effusion CEA (ng/mL)	3.8	0.878	78.9	92.5	7.4	0.783	47.5	96.7
Effusion/serum CEA	1.6	0.864	69.5	94.9	2.0	0.723	45.0	95.8
Serum CEA (ng/mL)	5.5	0.798	60.9	93.9	6.8	0.712	37.5	96.3
Effusion CA15-3 (U/mL)	16.0	0.766	53.9	89.3	17.3	0.768	52.5	89.3
Serum CYFRA21-1 (ng/mL)	3.4	0.762	68.0	73.8	4.0	0.760	62.5	81.3
Effusion CA19-9 (U/mL)	9.8	0.745	53.1	89.3	5.3	0.683	62.5	79.4
Effusion CA125 (U/mL)	799.4	0.701	61.7	73.8	481.6	0.620	67.5	51.9
Serum CA19-9 (U/mL)	18.1	0.683	53.9	76.6	94.2	0.610	25.0	99.5
Serum CA15-3 (U/mL)	21.5	0.645	43.0	84.1	26.5	0.576	32.5	87.9
Serum NSE (ng/mL)	14.7	0.636	57.8	66.4	11.8	0.646	87.5	36.0
Serum CA125 (U/mL)	142.8	0.585	50.0	70.1	236.0	0.536	35.0	83.6
Serum SCCA (ng/mL)	0.6	0.579	88.3	29.0	0.7	0.520	72.5	36.4

AUC, area under the curve; CA, carbohydrate antigen; CEA, carcinoembryonic antigen; CYFRA21-1, cytokeratin 19 fragment; MPE, malignant pleural effusion; NSE, neuron-specific enolase; SCCA, squamous cell carcinoma antigen.