

Supplementary Table 1. Detailed clinical, laboratory, pathologic, molecular and follow-up characteristics of 252 patients (training and validation sets) prospectively submitted for BiliSeq analysis.

Set	Patient	Gender	Age (years)	History of PSC	Serum CA19-9 (Units/mL)	Location of Stricture	Malignant Bile Duct Pathology Brushing/Biopsy**	Specimen for BiliSeq Testing	Molecular Alterations	Follow-up Diagnosis	Method of Follow-up Diagnosis	Status, Months of Follow-up
Training	1	F	82	No	1777.3	Hilar	N/S / Negative (CG)	Biopsy (CG)	<i>KRAS p.G12D, CTNNB1 p.S45Y</i>	Perihilar Cholangiocarcinoma	Liver EUS-FNA	Decreased, 4
Training	2	F	79	No	25	Distal	N/S / Positive (CG)	Biopsy (CG)	<i>KRAS p.Q61H, ATM p.K1706N</i>	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 12
Training	3	F	68	No	0.8	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Whipple Resection	Alive, 33
Training	4	M	76	No	635	Intrahepatic	N/S / Positive (CG)	Biopsy (CG)	<i>IDH1 p.R132C, BRAF p.G469V</i>	Intrahepatic Cholangiocarcinoma	Liver Core Needle Biopsy	Alive, 46
Training	5	M	79	No	33.9	Hilar	Negative / N/S	Brushings	<i>Negative</i>	Perihilar Cholangiocarcinoma	Partial Hepatectomy with Segmental Bile Duct Resection	Decreased, 2
Training	6	F	96	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Distal Cholangiocarcinoma	Autopsy	Decreased, 13
Training	7	M	73	No	25	Distal	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Distal Cholangiocarcinoma	Whipple Resection	Decreased, 25
Training	8	F	57	No	44	Hilar	N/S / Positive (CG)	Biopsy (CG)	<i>GNAS p.R201H</i>	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 46
Training	9	F	69	No	419	Distal	Negative / N/S	Brushings	<i>TP53 p.G199V</i>	Gallbladder Adenocarcinoma	Biopsy of Peritoneal Metastasis	Decreased, 12
Training	10	F	92	No	56.8	Distal	N/S / Positive (CS)	Biopsy (CS)	<i>Negative</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 31
Training	11	F	49	Yes	43	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Liver Transplantation	Alive, 34
Training	12	M	71	No	193	Distal	N/S / Positive (CS)	Biopsy (CS)	<i>TP53 p.R248W, SMAD4 copy number loss</i>	Distal Cholangiocarcinoma	Partial Hepatectomy with Segmental Bile Duct Resection	Alive, 35
Training	13	M	67	No	1551	Distal	Positive / Positive (CG)	Biopsy (CG)	<i>KRAS p.G12V</i>	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 35
Training	14	M	65	No	120.7	Distal	Negative / N/S	Biopsy (CG)	<i>KRAS p.G12A</i>	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 34
Training	15	M	51	No	13.2	Intrahepatic	N/S / Positive (CS)	Biopsy (CS)	<i>ERBB2 p.V777L, TP53 p.R273G, TP53 copy number loss, CDKN2A p.P70del, CTNNB1 p.S45F</i>	Intrahepatic Cholangiocarcinoma	Partial Hepatectomy	Decreased, 21
Training	16	M	70	No	49.6	Hilar	N/S / Positive (CS)	Biopsy (CS)	<i>KRAS p.G12D, CTNNB1 p.S45Y</i>	Perihilar Cholangiocarcinoma	Autopsy	Decreased, 15
Training	17	M	57	No	16.7	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Distal Cholangiocarcinoma	Whipple Resection	Alive, 49
Training	18	F	81	No	14	Hilar	N/S / Negative (CS)	Biopsy (CS)	<i>KRAS p.G12R</i>	Perihilar Cholangiocarcinoma	Subsequent ERCP Biopsy	Decreased, 6
Training	19	F	61	Yes	2498.5	Intrahepatic	Negative / N/S	Brushings	<i>KRAS p.G12V, TP53 p.R280T, CDKN2A copy number loss</i>	Intrahepatic Cholangiocarcinoma	Liver Core Needle Biopsy	Decreased, 4
Training	20	F	54	No	278.4	Hilar	Negative / N/S	Brushings	<i>Negative</i>	Perihilar Cholangiocarcinoma	Liver EUS-FNA	Decreased, 8
Training	21	M	45	No	7.8	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Liver Transplantation	Alive, 30
Training	22	M	64	No	66	Distal	Negative / N/S	Biopsy (CS)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 35
Training	23	F	34	No	23	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 30
Training	24	M	42	No	10.2	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 31
Training	25	M	78	No	118.9	Intrahepatic	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 36
Training	26	M	74	No	11.4	Distal	Positive / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Distal Cholangiocarcinoma	Whipple Resection	Decreased, 9
Training	27	M	36	No	4	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 33
Training	28	M	80	No	1841.9	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 30
Training	29	F	92	No	20000	Intrahepatic	Negative / N/S	Brushings	<i>KRAS p.G12D, TP53 p.R306*</i>	Perihilar Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 12
Training	30	M	64	Yes	3587	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>KRAS p.G13D</i>	Distal Cholangiocarcinoma	Biopsy of Liver Metastasis	Decreased, 27
Training	31	M	85	No	28.1	Distal	N/S / Positive (CS)	Biopsy (CS)	<i>TP53 c.902-1_931del</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Decreased, 23
Training	32	F	75	No	20.5	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 50
Training	33	F	73	No	249	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>KRAS p.G12D, TP53 p.C275F</i>	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 13
Training	34	M	72	Yes	39	Intrahepatic	Negative / N/S	Brushings	<i>GNAS p.R201C</i>	Intrahepatic Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 36
Training	35	M	57	No	148	Intrahepatic	N/S / Positive (CS)	Biopsy (CS)	<i>FGFR2 amplification, TP53 p.G244R</i>	Intrahepatic Cholangiocarcinoma	Liver Core Needle Biopsy	Decreased, 1
Training	36	M	26	Yes	316.4	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 35
Training	37	F	55	No	34793	Hilar	N/S / Negative (CG)	Biopsy (CG)	<i>ALK copy number gain</i>	Perihilar Cholangiocarcinoma	Biopsy of Small Intestinal Metastasis	Decreased, 14
Training	38	F	85	No	12	Intrahepatic	Negative / Negative (CS)	Biopsy (CS)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 28
Training	39	F	65	No	60	Hilar	N/S / Positive (CG)	Biopsy (CG)	<i>Negative</i>	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Omental Metastasis Biopsy	Decreased, 1
Training	40	F	61	No	362	Hilar	Negative / Negative (CG)	Both (CG)	<i>Both Specimens: Negative</i>	Gallbladder Adenocarcinoma	Cholecystectomy with Partial Hepatectomy	Decreased, 6
Training	41	M	79	No	3302	Hilar	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Perihilar Cholangiocarcinoma	Autopsy	Decreased, 12
Training	42	F	76	No	22	Distal	Negative / Negative (CS)	Biopsy (CS)	<i>Negative</i>	Gallbladder Adenocarcinoma	Cholecystectomy with Partial Hepatectomy	Alive, 29
Training	43	M	81	Yes	219.2	Distal	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 28
Training	44	F	53	Yes	38.1	Intrahepatic	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Liver Transplantation	Alive, 35
Training	45	F	75	No	17	Distal	Negative / Negative (CG)	Both (CG)	<i>Both Specimens: Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 31
Training	46	F	83	No	2.6	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 47
Training	47	M	63	Yes	9351	Intrahepatic	Negative / Negative (CS)	Biopsy (CS)	<i>KRAS p.G13D, GNAS p.R201H</i>	Perihilar Cholangiocarcinoma	Biopsy of Gastrohepatic Lymph Node Metastasis	Decreased, 14
Training	48	M	51	Yes	3.2	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 34
Training	49	F	62	No	0.8	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>KRAS p.G12D</i>	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 38
Training	50	M	84	No	1.2	Hilar	N/S / Negative (CS)	Biopsy (CS)	<i>Negative</i>	Distal Cholangiocarcinoma	Whipple Resection	Decreased, 15
Training	51	M	78	No	1	Distal	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 49
Training	52	M	76	No	3	Hilar	N/S / Positive (CS)	Biopsy (CS)	<i>Negative</i>	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy and Autopsy	Decreased, 3
Training	53	F	26	Yes	30	Distal	Negative / N/S	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 35
Training	54	F	52	Yes	35.4	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 46
Training	55	F	90	No	0.8	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Decreased, 12
Training	56	M	54	Yes	29.9	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 34
Training	57	M	59	No	20000	Distal	Positive / Positive (CG)	Biopsy (CG)	<i>KRAS p.G12R, TP53 p.R175H</i>	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Peritoneal Metastasis Biopsy	Decreased, 10
Validation	58	M	63	No	20460	Distal	Negative / N/S	Brushings	<i>Negative</i>	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 14
Validation	59	F	80	No	5	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	N/A	N/A	N/A
Validation	60	F	55	No	0.8	Distal	Negative / Negative (CG)	Biopsy (CG)	<i>KRAS p.G12V</i>	Pancreatic Ductal Adenocarcinoma	Intraoperative Pancreatic Biopsy	Alive, 12
Validation	61	F	85	No	12	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 21
Validation	62	F	47	No	184.9	Distal	N/S / Negative (CS)	Biopsy (CS)	<i>KRAS p.G12D</i>	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Alive, 14
Validation	63	F	83	No	10.7	Distal	N/S / Positive (CG)	Biopsy (CG)	<i>TP53 p.Y205F</i>	Ampullary adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Alive, 10
Validation	64	M	84	No	N/S	Distal	N/S / Positive (CG)	Biopsy (CG)	<i>KRAS p.G12C</i>	Ampullary adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Alive, 8
Validation	65	F	80	No	289.7	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 2
Validation	66	F	67	No	77	Distal	Negative / Positive (CG)	Biopsy (CG)	<i>Negative</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 16
Validation	67	M	59	No	N/S	Distal	Negative / Negative (CG)	Both (CG)	<i>Both Specimens: Negative</i>	N/A	N/A	N/A
Validation	68	M	52	No	N/S	Distal	Negative / Negative (CG)	Both (CG)	<i>Both Specimens: Negative</i>	N/A	N/A	N/A
Validation	69	M	89	No	297	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Distal Cholangiocarcinoma	Subsequent ERCP Biopsy	Decreased, 9
Validation	70	M	71	No	27.8	Distal	N/S / Positive (CG)	Biopsy (CG)	<i>TP53 p.Y236C</i>	Ampullary adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Alive, 6
Validation	71	M	83	No	146	Distal	N/S / Positive (CS)	Biopsy (CS)	<i>MET p.V184G</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Bile Duct Resection	Alive, 20
Validation	72	M	75	No	8	Distal	N/S / Positive (CG)	Biopsy (CG)	<i>TP53 p.E349*, CTNNB1 p.S45P</i>	Gallbladder Adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Liver Metastasis Biopsy	Decreased, 1
Validation	73	M	66	Yes	9.8	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 14
Validation	74	F	50	No	19	Distal	N/S / Negative (CS)	Biopsy (CS)	<i>Negative</i>	Distal Cholangiocarcinoma	Whipple Resection	Decreased, 17
Validation	75	M	65	No	1147.8	Distal	Negative / N/S	Brushings	<i>KRAS p.G12V</i>	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 20
Validation	76	M	82	No	N/S	Distal	Positive / Negative (CG)	Both (CG)	<i>Both Specimens: KRAS p.G12D, SMAD4 p.G176*</i>	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 15
Validation	77	F	88	No	15743	Distal	Negative / N/S	Brushings	<i>KRAS p.G12D, TP53 p.G245S</i>	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Alive, 7
Validation	78	M	58	No	61	Hilar	Negative / Negative (CS)	Biopsy (CS)	<i>Negative</i>	Intrahepatic Cholangiocarcinoma	Partial Hepatectomy	Alive, 21
Validation	79	F	79	No	164	Hilar	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Perihilar Cholangiocarcinoma	Subsequent ERCP Biopsy	Decreased, 1
Validation	80	F	78	No	880.5	Distal	Positive / Positive (CG)	Both (CG)	<i>Both Specimens: TP53 p.H179Y, SMAD4 p.R361H</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Omental Metastasis Biopsy	Alive, 16
Validation	81	F	81	No	N/S	Distal	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 17
Validation	82	F	88	No	45.1	Distal	Negative / Negative (CG)	Both (CG)	<i>Both Specimens: KRAS p.G12V, GNAS p.R201C, CDKN2A p.W110*</i>	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 3
Validation	83	M	73	No	480	Hilar	Negative / Negative (CS)	Biopsy (CS)	<i>Negative</i>	Perihilar Cholangiocarcinoma	Intraoperative Liver Biopsy	Alive, 15
Validation	84	F	56	No	2933.2	Distal	Negative / N/S	Brushings	<i>KRAS p.G12D</i>	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 6
Validation	85	F	67	No	109	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 21
Validation	86	F	67	No	20000	Distal	Negative / Positive (CG)	Biopsy (CG)	<i>TP53 p.R273H, CTNNB1 p.S45P</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Peritoneal Metastasis Biopsy	Decreased, 5
Validation	87	F	73	No	32.7	Distal	Negative / Negative (CG)	Both (CG)	<i>Brushings: KRAS p.G12V, CDKN2A p.T77fs*69; Biopsy: Negative</i>	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 10
Validation	88	M	61	No	N/S	Distal	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Liver Biopsy and Clinicoradiographic Impression	Decreased, 13
Validation	89	M	53	No	61	Hilar	Negative / Negative (CS)	Both (CS)	<i>Both Specimens: Negative</i>	N/A	N/A	N/A
Validation	90	M	83	No	3821	Hilar	Positive / Positive (CG)	Both (CG)	<i>Both Specimens: TP53 p.W91*, CDKN2A p.W110*, SMAD4 p.R496H</i>	Intrahepatic Cholangiocarcinoma	Concurrent ERCP Biopsy and Partial Hepatectomy	Alive, 6
Validation	91	F	59	Yes	97.7	Distal	Negative / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 18
Validation	92	M	78	Yes	238	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Decreased, 21
Validation	93	F	72	No	837.3	Hilar	Positive / Positive (CG)	Biopsy (CG)	<i>KRAS p.G12D, TP53 p.L206Wfs*41</i>	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Decreased, 3
Validation	94	F	86	No	131.7	Distal	N/S / Negative (CG)	Biopsy (CG)	<i>PIK3CA p.E545K, TP53 copy number loss, CDKN2A copy number loss</i>	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 12
Validation	95	M	72	No	303	Hilar	Negative / N/S	Brushings	<i>KRAS p.G12D, TP53 p.W91*</i>	Perihilar Cholangiocarcinoma	Autopsy	Decreased, 1
Validation	96	M	81	No	760.8	Hilar	Negative / N/S	Brushings	<i>Negative</i>	Cholangiopathy	Clinicoradiographic Impression	Alive, 20
Validation	97	F	46	Yes	226	Intrahepatic	Negative / N/S	Brushings	<i>Negative</i>	Intrahepatic Cholangiocarcinoma	Liver Core Needle Biopsy	Alive, 20

Validation	98	F	70	No	20000	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	Distal Cholangiocarcinoma	Biliary EUS-FNA	Alive, 8
Validation	99	F	60	No	4126.1	Distal	Positive / Positive (CG)	Biopsy (CG)	KRAS p.G12V, TP53 p.R175H	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy and Pancreatic EUS-FNA	Alive, 10
Validation	100	M	60	No	81	Distal	N/S / Negative (CS)	Biopsy (CS)	Negative	Cholangiopathy	Clinicoradiographic Impression	Decreased, 24
Validation	101	F	65	No	453.6	Hilar	N/S / Positive (CG)	Biopsy (CG)	MET copy number gain, TP53 p.R280I	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Ascitic Fluid Evaluation	Alive, 15
Validation	102	M	80	No	30.3	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 17
Validation	103	M	66	No	187.8	Distal	N/S / Positive (CG)	Biopsy (CG)	FGFR3 amplification, TP53 p.C176del, PIK3CA p.E542K, SMAD4 copy number loss	Distal Cholangiocarcinoma	Segmental Bile Duct Resection	Alive, 8
Validation	104	M	54	No	49.5	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	105	F	55	No	16	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 22
Validation	106	M	45	Yes	12	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 24
Validation	107	M	73	No	207	Hilar	Positive / Positive (CG)	Both (CG)	Both Specimens: KRAS p.G12A, TP53 p.A161T	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Partial Hepatectomy	Alive, 21
Validation	108	F	59	No	N/S	Intrahepatic	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Decreased, 22
Validation	109	M	76	No	20.6	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Whipple Resection	Alive, 21
Validation	110	M	33	No	N/S	Intrahepatic	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	111	M	91	No	4953	Intrahepatic	Positive / Positive (CG)	Biopsy (CG)	KRAS amplification, GNAS p.R201H	Intrahepatic Cholangiocarcinoma	Concurrent ERCP Biopsy	Decreased, 2
Validation	112	M	61	No	211.2	Distal	N/S / Positive (CG)	Biopsy (CG)	KRAS p.G12D	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy	Alive, 11
Validation	113	M	54	Yes	1033.4	Intrahepatic	Negative / N/S	Brushings	KRAS p.G12V, TP53 c.376-2A>G, splice site	Intrahepatic Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 25
Validation	114	F	72	No	133.3	Intrahepatic	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 23
Validation	115	M	76	No	251	Distal	Negative / Positive (CG)	Both (CG)	Both Specimens: KRAS p.G12C, ATM p.G1676E	Ampullary adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Decreased, 10
Validation	116	F	77	No	200	Distal	Positive / Positive (CG)	Both (CG)	Both Specimens: KRAS p.G12D, TP53 p.R213*	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Liver Metastasis Biopsy	Decreased, 8
Validation	117	F	77	No	38	Distal	N/S / Negative (CG)	Biopsy (CG)	KRAS p.G12D, TP53 p.R282W	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 9
Validation	118	F	71	No	27	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 19
Validation	119	F	74	No	10	Intrahepatic	N/S / Positive (CG)	Biopsy (CG)	KRAS p.G12D	Intrahepatic Cholangiocarcinoma	Partial Hepatectomy	Alive, 15
Validation	120	F	53	No	N/S	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 13
Validation	121	F	73	No	41	Intrahepatic	Negative / N/S	Brushings	GNAS p.R201H	N/A	N/A	N/A
Validation	122	M	56	No	4664.2	Distal	N/S / Positive (CG)	Biopsy (CG)	KRAS p.G12V	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy and Pancreatic EUS-FNA	Decreased, 7
Validation	123	F	84	No	4	Distal	Negative / Negative (CG)	Biopsy (CG)	NRAS p.G12S, BRAF p.G469R, PIK3CA p.C420R	Distal Cholangiocarcinoma	Biopsy of Peri-celiac Lymph Node Metastasis	Alive, 21
Validation	124	M	62	No	N/S	Hilar	Negative / N/S	Brushings	TP53 p.R175H, CDKN2A copy number loss	Perihilar Cholangiocarcinoma	Partial Hepatectomy	Decreased, 5
Validation	125	F	77	Yes	294.3	Intrahepatic	N/S / Positive (CS)	Biopsy (CS)	KRAS p.G12D	Intrahepatic Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Liver Core Needle Biopsy	Decreased, 1
Validation	126	M	89	No	2190.2	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: TP53 p.A161D	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 25
Validation	127	M	40	No	525.7	Distal	Positive / Positive (CG)	Both (CG)	Both Specimens: Negative	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Segmental Bile Duct Resection	Alive, 14
Validation	128	F	60	Yes	N/S	Intrahepatic	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	129	M	64	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	130	M	61	No	48	Distal	Negative / N/S	Brushings	KRAS p.G12V, TP53 p.H168Q	Distal Cholangiocarcinoma	Whipple Resection	Alive, 24
Validation	131	M	57	No	23	Distal	Negative / N/S	Brushings	TP53 p.C238Y	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Alive, 9
Validation	132	M	34	Yes	25.7	Intrahepatic	Negative / N/S	Brushings	Negative	Cholangiopathy	Liver Transplantation	Alive, 19
Validation	133	F	82	No	4616.1	Distal	Negative / N/S	Brushings	KRAS p.G12D, TP53 p.R248Q	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 6
Validation	134	F	56	No	9.9	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 18
Validation	135	F	86	No	4255.1	Hilar	Negative / N/S	Brushings	Negative	Cholangiopathy	Liver Core Needle Biopsy and Clinicoradiographic Impression	Decreased, 8
Validation	136	M	76	No	319	Distal	Negative / N/S	Brushings	KRAS p.G12D, TP53 p.C238F, CDKN2A p.E69*, CDKN2A p.L78Hfs*41	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 16
Validation	137	M	83	No	248.1	Distal	Negative / Negative (CG)	Biopsy (CG)	TP53 p.R249S	N/A	N/A	N/A
Validation	138	M	75	No	1722	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 7
Validation	139	M	73	No	1202	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 19
Validation	140	M	68	No	84	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Alive, 5
Validation	141	F	67	No	21	Distal	N/S / Negative (CS)	Biopsy (CS)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 12
Validation	142	M	81	No	25	Distal	Negative / N/S	Brushings	Negative	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 5
Validation	143	M	96	No	189.7	Hilar	N/S / Positive (CG)	Biopsy (CG)	FGFR3 p.A261Gfs*22, TP53, p.P191del	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Decreased, 1
Validation	144	M	66	No	N/S	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 13
Validation	145	M	88	No	17000	Distal	N/S / Positive (CG)	Biopsy (CG)	Negative	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Peritoneal Metastasis Biopsy	Decreased, 1
Validation	146	F	70	No	1197	Hilar	Positive / Positive (CS)	Biopsy (CS)	FGFR2 amplification, PIK3CA p.G1049R	Distal Cholangiocarcinoma	Autopsy	Decreased, 1
Validation	147	F	53	Yes	3	Hilar	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 21
Validation	148	M	70	No	159	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: KRAS p.G12D, CDKN2A p.R80*	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 4
Validation	149	M	55	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 19
Validation	150	M	60	No	6	Intrahepatic	Positive / Positive (CG)	Biopsy (CG)	KRAS p.G12D	Intrahepatic Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Liver Core Needle Biopsy	Decreased, 7
Validation	151	F	72	No	4.2	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	152	F	71	No	258	Distal	Negative / N/S	Brushings	Negative	Pancreatic Ductal Adenocarcinoma	Intraoperative Pancreatic Biopsy	Decreased, 1
Validation	153	F	55	No	90.4	Hilar	Negative / Negative (CS)	Both (CS)	Both Specimens: Negative	N/A	N/A	N/A
Validation	154	M	66	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	KRAS p.G12R	Ampullary adenocarcinoma	Whipple Resection	Alive, 12
Validation	155	M	66	No	53	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 13
Validation	156	M	80	No	3035.1	Distal	Negative / N/S	Brushings	TP53 p.R158H	Gallbladder Adenocarcinoma	Subsequent ERCP Biopsy	Decreased, 1
Validation	157	F	73	No	55	Intrahepatic	Negative / N/S	Brushings	ERBB2 amplification, TP53 p.C242fs*5	Intrahepatic Cholangiocarcinoma	Subsequent ERCP Biopsy	Alive, 23
Validation	158	F	70	No	29	Distal	N/S / Positive (CG)	Biopsy (CG)	KRAS p.G12V, TP53 p.P85Lfs*38, SMAD4 copy number loss	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Alive, 10
Validation	159	F	61	No	N/S	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	160	M	87	No	23	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Decreased, 21
Validation	161	M	79	No	81.6	Distal	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	162	F	61	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 12
Validation	163	F	80	No	2890.7	Distal	Negative / N/S	Brushings	Negative	Distal Cholangiocarcinoma	Subsequent ERCP Biopsy	Alive, 17
Validation	164	M	54	No	N/S	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	165	M	65	No	405.3	Distal	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	166	M	54	No	2383	Hilar	Positive / Positive (CG)	Biopsy (CG)	ERBB2 amplification, TP53 copy number loss, CDKN2A copy number loss	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 17
Validation	167	F	83	No	15.6	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 22
Validation	168	M	88	No	226	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: KRAS p.G12D	Pancreatic Ductal Adenocarcinoma	Biopsy of Peri-pancreatic Lymph Node Metastasis	Decreased, 3
Validation	169	F	77	No	N/S	Distal	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	170	M	46	Yes	12	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 26
Validation	171	F	81	No	N/S	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	172	M	52	No	2950.6	Distal	Positive / Positive (CG)	Biopsy (CG)	MET copy number gain, TP53 p.E198*	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Decreased, 3
Validation	173	M	65	Yes	537	Hilar	N/S / Negative (CG)	Biopsy (CG)	KRAS p.G12R, TP53 p.N131I	Intrahepatic Cholangiocarcinoma	Autopsy	Decreased, 6
Validation	174	M	83	No	6	Distal	Negative / Negative (CS)	Both (CS)	Both Specimens: Negative	N/A	N/A	N/A
Validation	175	M	57	No	43	Distal	Negative / Negative (CS)	Both (CS)	Both Specimens: Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 14
Validation	176	F	77	No	195.8	Hilar	Negative / Negative (CG)	Biopsy (CG)	FGFR2 p.S252W	Intrahepatic Cholangiocarcinoma	Clinicoradiographic Impression	Alive, 15
Validation	177	M	68	Yes	6	Intrahepatic	Negative / Negative (CS)	Biopsy (CS)	TP53 p.F338Lfs*6, CDKN2A p.R80*	High-grade dysplasia of the bile duct	Partial Hepatectomy	Alive, 12
Validation	178	M	61	No	47.1	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: KRAS p.G12V	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Alive, 10
Validation	179	F	74	Yes	40	Distal	Negative / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 15
Validation	180	M	71	Yes	N/S	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	181	F	73	Yes	5	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 18
Validation	182	F	58	No	15.5	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	183	M	68	No	4775.7	Distal	Negative / Positive (CG)	Both (CG)	Both Specimens: KRAS p.G12D, TP53 p.R282W	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy and Pancreatic EUS-FNA	Alive, 6
Validation	184	M	72	No	133.4	Hilar	Negative / Positive (CG)	Both (CG)	Both Specimens: KRAS p.G12V	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Partial Hepatectomy	Alive, 16
Validation	185	M	22	Yes	13.3	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 20
Validation	186	F	83	No	55	Distal	N/S / Negative (CS)	Biopsy (CS)	Negative	Gallbladder Adenocarcinoma	Cholecystectomy with Partial Hepatectomy	Alive, 5
Validation	187	F	63	No	458.4	Distal	Negative / N/S	Brushings	Negative	Gallbladder Adenocarcinoma	Cholecystectomy	Alive, 24
Validation	188	M	83	No	1108	Distal	N/S / Positive (CG)	Biopsy (CG)	Negative	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 14
Validation	189	F	63	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	KRAS p.G12V, TP53 p.H139L	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 11
Validation	190	M	38	Yes	6	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 23
Validation	191	M	84	No	28.6	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 22
Validation	192	M	61	No	97.6	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Decreased, 13
Validation	193	M	58	No	33	Distal	Negative / N/S	Brushings	KRAS p.G12D, TP53 copy number loss	Distal Cholangiocarcinoma	Subsequent ERCP Biopsy	Decreased, 14
Validation	194	F	48	No	6.8	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	195	M	57	No	274.9	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: KRAS p.Q61H	N/A	N/A	N/A
Validation	196	F	67	Yes	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	197	M	85	No	28.3	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	198	F	59	No	N/S	Distal	Negative / Negative (CS)	Biopsy (CS)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 25
Validation	199	M	85	No	N/S	Distal	Negative / Negative (CG)	Biopsy (CG)	TP53 p.R248Q, PIK3CA p.E545K	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 12

Validation	200	M	49	Yes	N/S	Distal	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	201	F	76	No	34	Distal	N/S / Positive (CG)	Biopsy (CG)	ERBB2 p.D769Y, CDKN2A copy number loss, SMAD4 p.G352 Y353del	Gallbladder Adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Cholecystectomy with Partial Hepatectomy	Decreased, 5
Validation	202	M	76	No	20000	Intrahepatic	Negative / N/S	Brushings	TP53 p.R248Q	Gallbladder Adenocarcinoma	Biopsy of Hepatic Artery Lymph Node Metastasis	Decreased, 8
Validation	203	F	71	No	760.6	Distal	Negative / N/S	Brushings	Negative	Distal Cholangiocarcinoma	Subsequent ERCP Biopsy	Alive, 12
Validation	204	F	44	Yes	5.5	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 12
Validation	205	F	72	No	22	Intrahepatic	Negative / Negative (CS)	Biopsy (CS)	Negative	Cholangiopathy	Liver Transplantation	Alive, 20
Validation	206	M	84	No	456	Hilar	Negative / Positive (CG)	Both (CG)	Both Specimens: Negative	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 19
Validation	207	M	42	Yes	0.9	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Liver Transplantation with Extended Bile Duct Resection	Alive, 17
Validation	208	F	70	No	54.5	Distal	Negative / N/S	Brushings	KRAS p.G12D, TP53 p.R248Q, CDKN2A p.R80*, SMAD4 p.R361G	Gallbladder Adenocarcinoma	Cholecystectomy with HIPEC	Decreased, 13
Validation	209	F	61	No	220.1	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 23
Validation	210	M	75	No	102	Hilar	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 21
Validation	211	M	68	No	20	Distal	N/S / Positive (CG)	Biopsy (CG)	ERBB2 p.T793M, GNAS p.R201H, SMAD4 p.D351H	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Decreased, 2
Validation	212	M	45	No	N/S	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	N/A	N/A	N/A
Validation	213	F	56	No	N/S	Distal	N/S / Positive (CG)	Biopsy (CG)	KRAS p.G12D, TP53 p.R342*	Ampullary adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Decreased, 6
Validation	214	F	76	No	247	Distal	N/S / Positive (CS)	Biopsy (CS)	KRAS p.G12V, TP53 p.T253P, CDKN2A copy number loss	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Alive, 9
Validation	215	F	77	No	199.7	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Decreased, 8
Validation	216	F	79	No	430	Hilar	N/S / Positive (CG)	Biopsy (CG)	TP53 p.Y163C, SMAD4 copy number loss	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Abdominal Wall Metastasis Biopsy	Decreased, 1
Validation	217	M	15	Yes	52.8	Intrahepatic	Negative / N/S	Brushings	Negative	Cholangiopathy	Liver Transplantation	Alive, 17
Validation	218	M	40	Yes	11.3	Intrahepatic	Negative / Negative (CS)	Both (CS)	Both Specimens: Negative	Intrahepatic Cholangiocarcinoma	Subsequent ERCP Biopsy	Alive, 18
Validation	219	F	78	No	78.3	Hilar	Negative / N/S	Brushings	Negative	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 14
Validation	220	M	71	No	160	Distal	Positive / Positive (CG)	Biopsy (CG)	ALK copy number gain, SMAD4 p.S144*	Distal Cholangiocarcinoma	Concurrent ERCP Biopsy	Decreased, 3
Validation	221	M	55	No	80.3	Hilar	Negative / Negative (CS)	Both (CS)	Both Specimens: TP53 p.Q104*, CDKN2A p.R58*	Gallbladder Adenocarcinoma	Biopsy of Peritoneal Metastasis	Decreased, 7
Validation	222	F	82	No	53	Distal	Negative / Negative (CS)	Both (CS)	Biopsy: KRAS p.G12C, TP53 p.A276D; Brushings: Negative	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Decreased, 10
Validation	223	M	63	No	3638	Distal	Negative / N/S	Brushings	Negative	N/A	N/A	N/A
Validation	224	F	78	No	7890	Distal	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 24
Validation	225	F	65	No	31.3	Distal	N/S / Negative (CG)	Biopsy (CG)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 13
Validation	226	M	67	No	N/S	Hilar	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	227	M	43	No	71.4	Intrahepatic	N/S / Negative (CS)	Biopsy (CS)	Negative	Intrahepatic Cholangiocarcinoma	Liver Core Needle Biopsy	Alive, 15
Validation	228	F	83	No	N/S	Distal	Negative / Negative (CG)	Biopsy (CG)	KRAS p.G12S, PIK3CA p.H1047R	High-grade dysplasia of the bile duct	Whipple Resection	Alive, 26
Validation	229	M	58	No	80.4	Hilar	Negative / N/S	Brushings	KRAS p.G12D, GNAS p.R201H, TP53 p.E336*, CDKN2A p.H83Y	Perihilar Cholangiocarcinoma	Liver EUS-FNA	Alive, 21
Validation	230	M	68	No	88.5	Intrahepatic	Negative / N/S	Brushings	Negative	Intrahepatic Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 12
Validation	231	M	62	No	N/S	Intrahepatic	N/S / Positive (CS)	Biopsy (CS)	IDH2 p.R140L, TP53 p.R333Lfs*12, CTNNB1 p.G34R	Mixed HCC-Cholangiocarcinoma	Concurrent ERCP Biopsy	Alive, 7
Validation	232	M	55	No	46.5	Hilar	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	233	M	73	No	187.1	Distal	N/S / Positive (CG)	Biopsy (CG)	TP53 p.P151T, CTNNB1 p.S45F, SMAD4 p.R361H	Intrahepatic Cholangiocarcinoma	Concurrent ERCP Biopsy	Decreased, 5
Validation	234	M	58	No	606	Hilar	Negative / Negative (CS)	Both (CS)	Both Specimens: TP53 p.R248W	Perihilar Cholangiocarcinoma	Partial Hepatectomy	Alive, 5
Validation	235	F	75	No	164.2	Distal	N/S / Positive (CG)	Biopsy (CG)	IDH2 p.I170M, TP53 copy number loss	Ampullary adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Whipple Resection	Alive, 6
Validation	236	F	70	No	452	Hilar	Negative / N/S	Brushings	TP53 p.I232S	Perihilar Cholangiocarcinoma	Subsequent ERCP Biopsy	Alive, 23
Validation	237	F	70	Yes	137.2	Distal	Negative / Negative (CG)	Both (CG)	Biopsy: KRAS p.G12V, PIK3CA p.C901F; Brushings: Negative	Distal Cholangiocarcinoma	Clinicoradiographic Impression	Decreased, 13
Validation	238	M	64	No	52.4	Distal	Negative / Negative (CS)	Both (CS)	Biopsy: KRAS p.G13D; Brushings: Negative	Distal Cholangiocarcinoma	Whipple Resection	Alive, 14
Validation	239	F	79	No	10392.4	Distal	Negative / N/S	Brushings	KRAS p.G12D	Pancreatic Ductal Adenocarcinoma	Whipple Resection	Alive, 16
Validation	240	M	76	No	4.5	Distal	N/S / Negative (CS)	Biopsy (CS)	KRAS p.G12V	Distal Cholangiocarcinoma	Biopsy of Omental Metastasis	Decreased, 5
Validation	241	M	80	No	187.7	Hilar	N/S / Positive (CS)	Biopsy (CS)	SMAD4 p.H528Yfs*8, SMAD4 copy number loss, AKT1 copy number loss	Perihilar Cholangiocarcinoma	Concurrent ERCP Biopsy and Subsequent Partial Hepatectomy	Decreased, 2
Validation	242	M	69	No	15	Distal	N/S / Negative (CG)	Biopsy (CG)	KRAS p.Q61H	N/A	N/A	N/A
Validation	243	F	91	No	64	Hilar	Negative / Negative (CS)	Biopsy (CS)	PIK3CA p.H1047R	Intrahepatic Cholangiocarcinoma	Subsequent ERCP Biopsy	Decreased, 5
Validation	244	M	33	No	N/S	Distal	N/S / Positive (CG)	Biopsy (CG)	KRAS p.G12D, TP53 p.R248Q	Pancreatic Ductal Adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Omental Metastasis Biopsy	Decreased, 14
Validation	245	M	65	No	115.3	Hilar	N/S / Negative (CS)	Biopsy (CS)	TP53 p.V173M	Perihilar Cholangiocarcinoma	Partial Hepatectomy with Segmental Bile Duct Resection	Alive, 21
Validation	246	F	30	Yes	0.8	Intrahepatic	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 15
Validation	247	M	65	No	118	Distal	Negative / N/S	Brushings	KRAS p.G12R	Pancreatic Ductal Adenocarcinoma	Pancreatic EUS-FNA	Alive, 5
Validation	248	M	59	No	136.5	Distal	Negative / Negative (CG)	Both (CG)	Both Specimens: Negative	N/A	N/A	N/A
Validation	249	F	70	No	N/S	Distal	Positive / Positive (CG)	Biopsy (CG)	BRAF p.V600E, BRAF p.S605N, TP53 p.R213*, SMAD4 p.S178*	Metastatic colonic adenocarcinoma	Concurrent ERCP Biopsy and Subsequent Liver Core Needle Biopsy	Decreased, 1
Validation	250	M	76	Yes	25.2	Hilar	Negative / N/S	Brushings	KRAS p.G12D	Intrahepatic Cholangiocarcinoma	Liver Core Needle Biopsy	Decreased, 9
Validation	251	M	71	Yes	8.7	Intrahepatic	Negative / N/S	Brushings	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 21
Validation	252	M	69	Yes	266.4	Hilar	N/S / Negative (CS)	Biopsy (CS)	Negative	Cholangiopathy	Clinicoradiographic Impression	Alive, 26

Abbreviations: CG, cholangiographic-guided biopsy; CS, cholangioscopic-guided biopsy; N/A, not available; N/S, not submitted; PSC, primary sclerosing cholangitis

**Malignant biliary duct pathology of brushings/biopsies was defined as at least high-grade dysplasia or at least suspicious for malignancy.