

SUPPLEMENTAL MATERIAL

Table S1. Presenting symptoms for cancer patients with intracranial hemorrhage (n = 704)

Symptom	No. of patients (%)
Headache	297 (42.2)
Altered mental status	253 (35.9)
Paresis/weakness	185 (26.3)
Nausea/vomiting	145 (20.6)
Fall/trauma	122 (17.3)
Speech changes	79 (11.2)
Seizure	72 (10.2)
Dizziness	64 (9.1)
Visual changes	45 (6.4)
Loss of consciousness	31 (4.4)
Numbness	20 (2.8)

Table S2. Characteristics of ICH in cancer patients

Characteristic	No. of patients (%)			P
	Total	Spontaneous ICH	Traumatic ICH	
Total	704	576	128	
ICH location				<0.001
Subdural hematoma	248 (35.2)	169 (29.3)	79 (61.7)	
Hemorrhagic metastasis	199 (28.3)	192 (33.3)	7 (5.5)	
Intraparenchymal hemorrhage	74 (10.5)	68 (11.8)	6 (4.7)	
Subarachnoid hemorrhage	62 (8.8)	41 (7.1)	21 (16.4)	
Hemorrhage in primary tumor	40 (5.7)	36 (6.3)	4 (3.1)	
Intraventricular hemorrhage	25 (3.6)	19 (3.3)	6 (4.7)	
Postsurgical hemorrhage	17 (2.4)	17 (3.0)	0 (0.0)	
Cerebellar hemorrhage	17 (2.4)	16 (2.8)	1 (0.8)	
Basal ganglia hemorrhage	9 (1.3)	8 (1.4)	1 (0.8)	
Brainstem hemorrhage	3 (0.4)	3 (0.5)	0 (0.0)	
Epidural hematoma	8 (1.1)	5 (0.9)	3 (2.3)	
Thalamic hemorrhage	2 (0.3)	2 (0.3)	0 (0.0)	
Associated edema				<0.001
No	372 (52.8)	277 (48.1)	95 (74.2)	
Yes	332 (47.2)	299 (51.9)	33 (25.8)	
Midline shift				0.087
No	463 (65.8)	370 (64.2)	93 (72.7)	
Yes	241 (34.2)	206 (35.8)	35 (27.3)	
Herniation				0.646
No	611 (86.8)	502 (87.2)	109 (85.2)	
Yes	93 (13.2)	74 (12.8)	19 (14.8)	
Hydrocephalus				0.434
No	627 (89.1)	510 (88.5)	117 (91.4)	
Yes	77 (10.9)	66 (11.5)	11 (8.6)	

Abbreviations: ICH, intracranial hemorrhage. Boldface indicates statistical significance.

Table S3. Types of brain herniation in cancer patients presenting with intracranial hemorrhage

Herniation type	No. of patients*
Subfalcine herniation	35 (5.0%)
Uncal herniation	30 (4.3%)
Transtentorial except Uncal herniation	19 (2.7%)
Cerebellar tonsillar herniation	14 (2.0%)
Others or undefined	17 (2.4%)

*Some patients had more than one type of herniation at the same time

Table S4. Primary cancer type for the metastatic brain lesions

Primary cancer type	No. of patients (%)
Melanoma	94 (47.2)
Lung	37 (18.6)
Breast	15 (7.5)
Sarcoma	12 (6.0)
Kidney	7 (3.5)
Thyroid	6 (3.0)
Gastrointestinal	6 (3.0)
Head and neck	4 (2.0)
Others	18 (9.0)

Table S5. Radiological findings stratified by bleeding type

Radiological finding	No. of patients (%)			<i>P</i>
	Intra-metastatic bleeding	Intra-primary tumor bleeding	Other bleeds	
Associated edema				<0.001
No	48 (24.1)	13 (32.5)	311 (66.9)	
Yes	151 (75.9)	27 (67.5)	154 (33.1)	
Midline shift				0.006
No	146 (73.4)	20 (50.0)	297 (63.9)	
Yes	53 (26.6)	20 (50.0)	168 (36.1)	
Herniation				0.228
No	178 (89.4)	32 (80.0)	401 (86.2)	
Yes	21 (10.6)	8 (20.0)	64 (13.8)	
Hydrocephalus				0.462
No	173 (86.9)	35 (87.5)	419 (90.1)	
Yes	26 (13.1)	5 (12.5)	46 (9.9)	

Table S6. Univariate analysis of the association between clinical factors and hospital outcomes in cancer patients with intracranial hemorrhage

Variable	Hospital LOS†		ICU admission	
	OR (95% CI)	P	OR (95% CI)	P
Age <65 years (compared with ≥65 years)	0.71 (0.14-3.53)	0.677	0.98 (0.72-1.34)	0.904
Male (compared with female)	0.86 (0.18-4.07)	0.846	0.81 (0.60-1.09)	0.162
White (compared with non-White)	0.82 (0.15-4.53)	0.818	0.96 (0.69-1.34)	0.815
CCI	0.66 (0.50-0.86)	0.002	0.98 (0.93-1.03)	0.372
Hematologic malignancy (compared with solid tumors)	13.45 (2.86-63.22)	0.001	1.88 (1.39-2.55)	<0.001
Active cancer status	0.16 (0.01-1.96)	0.150	0.71 (0.43-1.14)	0.164
Active cancer therapy	0.34 (0.07-1.78)	0.202	0.89 (0.65-1.23)	0.479
Hypertension	4.02 (0.85-19.09)	0.079	1.63 (1.20-2.21)	0.002
Hypercholesterolemia	1.08 (0.16-7.45)	0.939	1.48 (1.02-2.16)	0.041
Current smoker	0.1 (0.00-11.85)	0.340	1.29 (0.53-3.11)	0.563
Dysrhythmia	9.94 (0.60-163.39)	0.108	1.22 (0.71-2.06)	0.464
Antiplatelets used within 90 days	1.31 (0.04-41.39)	0.879	1.22 (0.63-2.34)	0.542
Anticoagulants used within 90 days	0.71 (0.08-6.66)	0.766	0.69 (0.44-1.08)	0.110
Hemoglobin level, gm/dL	0.73 (0.53-1.01)	0.057	0.90 (0.85-0.96)	0.002
Intratumor bleeding	0.10 (0.02-0.49)	0.005	0.47 (0.33-0.65)	<0.001
Platelet count (increment of 10)	0.89 (0.84-0.95)	<0.001	0.98 (0.96-0.99)	<0.001
Platelet count <50 (compared with ≥50)	27.96 (5.20-150.4)	<0.001	2.22 (1.60-3.09)	<0.001

*Abbreviations: LOS, length of stay; ICU, intensive care unit; OR, odds ratio; CI, confidence interval; CCI, Charlson comorbidity index.

†Patients who died in the hospital were excluded.

Table S7. Mortality in cancer patients with intracranial hemorrhage, stratified by cancer type

Cancer type	No. of patients	No. of deaths (% of subgroup)		
		7-day mortality	30-day mortality	1-year mortality
Brain and spinal cord	89	6 (6.7)	13 (14.6)	49 (55.1)
Breast	37	2 (5.4)	7 (18.9)	19 (51.4)
Gastrointestinal	36	6 (16.7)	10 (27.8)	29 (80.6)
Head and neck	21	1 (4.8)	6 (28.6)	13 (61.9)
Leukemia	196	31 (15.8)	63 (32.1)	138 (70.4)
Lung	65	7 (10.8)	17 (26.2)	56 (86.2)
Lymphoma	30	1 (3.3)	4 (13.3)	15 (50.0)
Melanoma	123	13 (10.6)	29 (23.6)	91 (74.0)
Multiple myeloma	24	6 (25.0)	12 (50.0)	17 (70.8)
Other	60	3 (5.0)	9 (15.0)	31 (51.7)
Sarcoma	23	4 (17.4)	10 (43.5)	18 (78.3)

Table S8. Mortality rates and ICU admission stratified by intracranial hemorrhage type

Outcome	Intraparenchymal hemorrhage	Subdural hematoma	Intraventricular hemorrhage	Hemorrhagic tumor	Subarachnoid hemorrhage	Others	<i>P</i>
Total	74	248	25	239	62	56	
In-hospital mortality	25 (33.8)	45 (18.1)	2 (8.0)	18 (7.5)	8 (12.9)	8 (14.3)	<0.001
7-days mortality	21 (28.4)	26 (10.5)	3 (12.0)	17 (7.1)	6 (9.7)	7 (12.5)	<0.001
30-days mortality	31 (41.9)	65 (26.2)	7 (28.0)	57 (23.9)	10 (16.1)	10 (17.9)	0.009
ICU admission	44 (59.5)	107 (43.1)	15 (60.0)	71 (29.7)	31 (50.0)	24 (42.9)	<0.001

*Abbreviations: ICU, intensive care unit.

Table S9. Univariate analysis of the association between clinical factors and short-term mortality in cancer patients with intracranial hemorrhage

Variable	In-hospital mortality		7-day mortality		30-day mortality	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Age <65 years (compared with ≥65 years)	0.80 (0.53-1.22)	0.290	0.67 (0.42-1.07)	0.093	0.85 (0.60-1.21)	0.366
Male (compared with female)	0.79 (0.52-1.19)	0.263	0.69 (0.43-1.11)	0.126	0.73 (0.52-1.02)	0.069
White (compared with non-White)	0.89 (0.57-1.40)	0.596	1.17 (0.70-2.02)	0.562	1.05 (0.72-1.53)	0.814
CCI	0.98 (0.92-1.06)	0.676	0.99 (0.92-1.08)	0.884	1.04 (0.98-1.10)	0.178
Hematologic malignancy (compared with solid tumors)	2.17 (1.42-3.36)	<0.001	1.37 (0.86-2.19)	0.189	1.18 (0.84-1.65)	0.346
Active cancer status	0.90 (0.44-1.70)	0.765	0.73 (0.30-1.55)	0.456	0.54 (0.28-0.97)	0.051
Active cancer therapy	1.23 (0.79-1.96)	0.361	1.26 (0.76-2.14)	0.376	1.62 (1.12-2.39)	0.013
Hypertension	1.05 (0.69-1.58)	0.828	1.10 (0.68-1.75)	0.701	0.98 (0.70-1.38)	0.913
Current smoker	1.34 (0.38-3.71)	0.605	1.31 (0.30-3.98)	0.671	0.91 (0.29-2.35)	0.848
Dysrhythmia	1.43 (0.70-2.71)	0.294	1.83 (0.87-3.56)	0.091	1.14 (0.62-2.01)	0.672
Antiplatelets used within 90 days	1.49 (0.62-3.20)	0.330	0.64 (0.15-1.82)	0.459	0.74 (0.31-1.56)	0.455
Anticoagulants used within 90 days	1.04 (0.55-1.83)	0.904	0.88 (0.41-1.70)	0.721	0.95 (0.57-1.54)	0.834
Intratumor bleeding	0.35 (0.20-0.58)	<0.001	0.49 (0.27-0.84)	0.013	0.88 (0.61-1.25)	0.472
Platelet count (increment of 10)	0.95 (0.93-0.97)	<0.001	0.97 (0.95-0.99)	0.003	0.97 (0.96-0.99)	<0.001
Platelet count <50 (compared with ≥50)	3.41 (2.24-5.23)	<0.001	2.57 (1.60-4.13)	<0.001	2.24 (1.57-3.19)	<0.001
Hemoglobin level, gm/dL	0.83 (0.76-0.91)	<0.001	0.90 (0.81-0.99)	0.036	0.86 (0.80-0.93)	<0.001

*Abbreviations: OR, odds ratio; CI, confidence interval; CCI, Charlson comorbidity index. Boldface indicates statistical significance.

Table S10. Univariate analysis of the association between radiologic findings and short-term mortality in cancer patients with intracranial hemorrhage

Radiologic finding	In-hospital mortality		7-day mortality		30-day mortality	
	OR (95% CI)	<i>P</i>*	OR (95% CI)	<i>P</i>*	OR (95% CI)	<i>P</i>*
Edema	1.14 (0.76-1.73)	0.525	1.6 (1.01-2.58)	0.049	1.28 (0.91-1.80)	0.154
Midline shift	2.39 (1.57-3.64)	<0.001	3.37 (2.10-5.48)	<0.001	1.65 (1.16-2.34)	0.005
Herniation	6.23 (3.84-10.11)	<0.001	9.34 (5.56-15.75)	<0.001	4.78 (3.04-7.55)	<0.001
Hydrocephalus	2.79 (1.60-4.74)	<0.001	4.61 (2.62-7.98)	<0.001	2.94 (1.80-4.77)	<0.001

*Boldface indicates statistical significance

Table S11. Anticoagulant agents (excluding heparin) used in cancer patients with ICH

Anticoagulant agent	No. of patients (%)		
	Total, n=704	Spontaneous ICH, n=576	Traumatic ICH, n=128
Enoxaparin	90 (12.8)	73 (12.7)	17 (13.3)
Dalteparin	5 (0.7)	5 (0.9)	0 (0.0)
Warfarin	9 (1.3)	3 (0.5)	6 (4.7)

*Abbreviations: ICH, intracranial hemorrhage.