

# Subarachnoid hemorrhage in pediatric patients: Impact of surgeon-dependent factors on perioperative outcomes

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## Introduction

The evidence base for pediatric subarachnoid hemorrhage is sparse. Despite recent debates over treatment choices and time to treatment, little is known about how these factors impact pediatric outcomes. We evaluated the relationships between perioperative outcomes and a variety of surgeon-dependent and -independent factors for children with subarachnoid hemorrhage.

**Table 1: Chi-squared test between covariates and perioperative outcomes of interest in pediatric patients who underwent treatment for aneurysmal SAH**

	n	Complication		Mortality		Routine Discharge		p
		n	%	n	%	n	%	
Total	101	49	52.7	3	3.2	64	68.8	
Time to treat (hrs)								
<=48	67	72.0	35	52.2	0.889	3	4.5	0.157
>48	26	28.0	14	53.9		0	0	
Age (yrs)								
0-9	22	21.8	15	68.2	0.151	0	0.0	0.283
10-14	33	32.7	18	54.6		1	3.0	
15-18	46	45.5	20	43.5	0.990	3	6.5	0.967
Sex								
Male	51	51.0	27	52.9	0.582	2	3.9	0.681
Female	49	49.0	26	53.1		2	4.1	
Race								
White	34	46.6	18	52.9	0.296	1	2.5	0.903
Black	13	17.9	6	46.2	1	2.9	23	67.7
Hispanic	16	21.9	9	56.3	0.133	3	4.5	0.288
Asian	2	2.7	0	0.0		0	0.0	
Nat.Amer.	2	2.7	1	1.4		0	0.0	
Other	6	8.2	4	66.7	0.001	1	2.0	0.200
Adm. Source								
ED	40	40.4	25	62.5	0.001	1	2.5	0.702
Transfer	34	34.3	14	14.1		1	2.9	
Health Fac.	5	5.1	2	2.0		0	0.0	
Routine	20	20.2	10	10.1		1	5.0	
EVD								
Yes	34	33.7	34	100.0	1	2.9	21	61.8
No	67	66.3	19	18.8	0.133	3	4.5	0.288
Intervention								
Clip	50	49.5	30	60.0	0.001	3	6.0	0.200
Coil	51	50.5	23	45.1		1	2.0	
Severity score*								
1	3	4.2	0	0.0	0.001	0	0.0	0.267
2	15	20.8	6	40.0		0	0.0	
3	34	47.2	15	44.1		3	8.8	
4	20	27.8	17	85.0		0	0.0	
Comorb. score								
>0								

## Methods

We selected a cohort of pediatric patients with subarachnoid hemorrhage from the Nationwide Inpatient Sample who underwent clipping or coiling. Primary outcomes were mortality, complication, routine discharge, and length of stay. These were analyzed with multivariate regression to assess for associations with demographic and clinical variables.

**Table 2: Multivariate logistic regression models assessing the relation of time to treatment to complication, mortality, and routine discharge in pediatric patients who underwent treatment for aneurysmal subarachnoid hemorrhage**

	OR	Complication		Mortality		Routine discharge		p
		CI	p	CI	p	CI	p	
Time to treat (hrs)								
<=48	1.38	0.37 - 1.41	0.339	0.47	0.25 - 0.87	0.016	ref	
>48	ref	ref	ref	ref	ref	ref	ref	
Age (yrs)								
0-9	1.19	0.54 - 2.68	0.662	3.06	1.25 - 8.00	0.014	ref	
10-14	0.49	0.24 - 0.97	0.042	0.88	0.46 - 1.67	0.696	ref	
15-18	ref	ref	ref	ref	ref	ref	ref	
Sex								
Male	1.05	0.57 - 1.94	0.877	0.48	0.14 - 1.42	0.191	1.26	0.70 - 2.29
Female	ref	ref	ref	ref	ref	ref	ref	ref
Comorbidity score*								
>0	2.03	1.06 - 3.97	0.031	2.77	0.92 - 9.51	0.069	1.77	0.93 - 3.42
0	ref	ref	ref	ref	ref	ref	ref	ref
Intervention								
Clip	3.05	1.67 - 5.74	0.0003	3.00	1.01 - 10.2	0.048	0.66	0.36 - 1.19
Coil	ref	ref	ref	ref	ref	ref	ref	ref
Admission source								
ED							0.27	0.10 - 0.66
Transfer							0.29	0.11 - 0.67
Health facility							0.06	0.01 - 0.26
Routine							ref	ref
EVD								
Yes							0.83	0.24 - 2.47
No							ref	ref
Severity score*								
1							0.49	0.11 - 2.24
2							2.90	1.28 - 6.72
3							4.66	2.30 - 9.85
4							ref	ref

**Table 3: Univariate and multivariate analysis of variance test between covariates and length of stay in pediatric patients who underwent treatment for aneurysmal subarachnoid hemorrhage**

	mean (days)	SE	Univariate p	Multivariate p
Total	19.5	1.8		
Time to treat (hrs)				
<=48	17.0	2.2	0.015	0.007
>48	17.3	3.5		
Age (yrs)			0.607	0.405
0-9	22.9	3.9		
10-14	18.1	3.2		
15-18	18.9	2.7		
Sex			0.478	0.743
Male	20.9	2.6		
Female	18.3	2.6		
Race			0.713	0.766
White	18.7	3.3		
Black	16.1	5.3		
Hispanic	19.0	4.8		
Asian	17.5	13.5		
Native American	14.5	13.5		
Other/unknown	31.3	7.8		
Comorbidity score*			0.025	0.256
0	15.0	2.9		
>0	24.5	3.0		
Admission source			0.052	0.056
ED	20.6	2.8		
Transfer	18.9	3.0		
Health facility	39.2	7.9		
Routine	14.5	4.0		
EVD			0.0003	0.017
Yes	28.4	2.9		
No	15.0	2.1		
Intervention			0.457	0.502
Clipping	20.9	2.6		
Endovascular	18.2	2.5		
Severity score*			0.001	0.594
1	4.3	9.5		
2	11.1	4.3		
3	17.6	2.8		
4	31.8	3.7		

## Results

We identified 101 pediatric patients with subarachnoid hemorrhage that were treated with coiling (n=51) or clipping (n=50). Illness severity score was most strongly associated with complications (OR 0.01, p=0.013, for score of 3 vs. 4). Although patients who underwent clipping were found to have more complications (OR 3.44, p=0.027), the rates of mortality, routine discharge to home, and length of stay were not significantly different. Length of stay was strongly associated with ventriculostomy placement (28.4 vs 18.2 days, p=0.018) as well as worse initial severity score (31.8 vs. 17.6 days, p=0.036). We further analyzed these outcomes as a function of time to treatment, but only found significant

## Conclusions

Pediatric subarachnoid patients have relatively low mortality rates despite high rates of complications. Clipping and coiling were equally represented, but this choice had little impact on outcome. Furthermore, time to treatment was not associated with any functional outcomes. Our analysis suggests that the severity of the patient's initial presentation is the single factor most highly correlated with outcomes, which also correlates with ventriculostomy placement. Thus, surgeon-related factors are secondary to those of the primary disease process in determining pediatric subarachnoid outcomes.

**Table 4: Analysis of accrued charges by time to treatment for aneurysmal subarachnoid hemorrhage in pediatric patients**

	mean (days)	SE	Univariate p	Multivariate p
Total				
Time to treat (hrs)				
<=48	115,979	113,045	0.003	0.052
>48	180,521	120,556		
Age (yrs)			0.286	0.996
0-9	148,250	115,723		
10-14	145,679	109,857		
15-18	147,823	115,716		
Sex			0.445	0.472
Male	156,457	114,782		
Female	140,043	117,754		
Race			0.558	0.610
White	138,578	111,152		
Black	135,715	116,524		
Hispanic	155,704	119,426		
Asian	250,927	141,740		
Native American	70,313	128,979		
Other/unknown	138,262	117,083		
Comorbidity score*			>0.0001	0.268
Admission source			>0.0001	0.0002
ED	65,974	111,116		
Transfer	214,628	118,518		
Health facility	201,386	131,202		
Routine	111,011	115,588		
EVD			>0.0001	0.0002
Yes	213,168	117,568		
No	83,332	117,568		
Intervention			0.779	0.666
Clipping	217,083	51,940		
Endovascular	202,165	50,370		
Both	148,250	115,723		
Severity score*			>0.0001	0.053
1	148,250	115,723		
2	136,668	111,972		
3	163,062	107,668		
4	236,96	114,621		