Impact of External Ventricular Drainage Utilization on Mortality and Functional Outcomes After Intracerebral Hemorrhage

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Learning Objectives

1) Understand the impact of EVD utilization on ICH patient outcomes

2) Discuss the impact of IVH co-presentation on mortality and outcomes in ICH patients

Introduction

-- Spontaneous intracerebral hemorrhage (ICH), commonly presents with intraventricular hemorrhage (IVH) and remains one of the most disabling forms of stroke.

-- Extraventricular drains (EVDs) are associated with decreased IVH mortality, but their indications for utilization and outcomes benefit remain undefined.

Study Aims

Determine the impact of EVD utilization on mortality and functional outcomes after ICH.

Patient Characteristics	Overall (N = 584)	EVD Required (N = 149)	No EVD Required (N = 435)	P-value
Age at Admission Mean ± SD	58.1 ± 13.6	54.6 ± 11.4	59.3 ± 14.1	.003**
Sex, N (%)				
Male	322 (55.1%)	79 (53.0%)	243 (55.9%)	.54
Female	262 (44.9%)	70 (47.0%)	192 (44.1%)	
Location of ICH[1], N (%)				
Basal Ganglia	310 (53.2%)	92 (61.7%)	218 (50.2%)	.01*
Lobar	188 (32.3%)	32 (21.5%)	156 (35.9%)	.001**
Cerebellum	61 (10.5%)	24 (16.1%)	37 (8.5%)	.009**
Brainstem	37 (6.4%)	2 (1.3%)	25 (8.1%)	.004**
GCS at Admission Median (25^{th} – 75^{th})	13 (6 – 15)	9 (6 – 13)	14 (7 – 15)	<.001**
ICH Volume Median (25^{th} – 75^{th})	10.7 (3.5 – 30.4)	15.6 (5.1 – 31.8)	8.9 (2.1 – 28.3)	.01*
IVH, N (%)	293 (50.2%)	125 (83.9%)	168 (38.6%)	<.001***
mGraeb Score Median (25^{th} – 75^{th})	1 (0 -12)	13 (5 – 19)	0 (0 – 5)	<.001***
ICH Score, N (%)				
0	164 (28.1%)	8 (5.4%)	156 (35.9%)	<.001***
1	142 (24.3%)	28 (18.8%)	114 (26.2%)	
2	102 (17.5%)	51 (34.2%)	51 (11.7%)	
3	91 (15.6%)	44 (29.5%)	47 (10.8%)	
4	69 (11.8%)	16 (10.7%)	53 (12.2%)	
5	16 (2.7%)	2 (1.3%)	14 (3.2%)	
30-day Mortality N (%)	139 (24.4%)	45 (31.3%)	94 (22.1%)	.02*

[1] Multiple options may apply. * p < .05; ** p <.01; *** p <.001

Table 1: Patient and hemorrhage characteristics of spontaneous ICH with and without EVD utilization

Methods

-- Bi-institutional retrospective analysis of 553 patients with spontaneous ICH from 2010-2013 was performed using multivariate regression modeling.

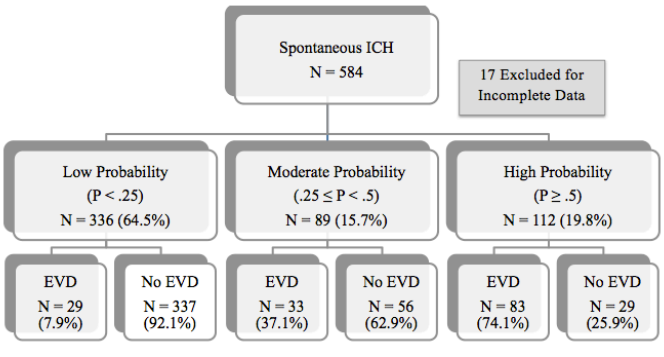
-- A stratified propensity analysis was performed to control for differences in patient/clinical characteristics influencing EVD utilization, including: age, sex, GCS, ICH location and volume, IVH presence, mGraeb Score, and ICH Score.

-- Patients were further stratified based on predicted probability of EVD utilization (Low Prob<0.25, Moderate Prob 0.25-0.5, and High Prob>0.5).

Characteristic (N = 567)	Odds Ratio	95% CI	P-value
Age (per year)	0.96	(0.94 – 0.97)	< .001***
Sex-Male	0.89	(0.54 – 1.46)	.65
ICH Location			
Lobar	2.83	(0.32 – 25.05)	.35
Basal Ganglia	0.38	(0.04 – 3.43)	.38
Cerebellum	1.20	(0.11 – 12.81)	.88
Non-Brainstem	41.16	(2.42 – 701.09)	.01*
IVH	2.89	(1.14 – 7.34)	.02*
Modified Graeb Score (per point)	1.10	(1.05 – 1.15)	< .001***
ICH Volume (per cc)	0.99	(0.98 – 1.00)	.10
GCS on admission (per point)	0.95	(0.85 – 1.05)	.31
ICH Score			
0	6.09	(0.41 – 121.5)	.23
1	9.71	(0.79 – 119.97)	.07
2	34.92	(3.81 – 319.98)	.002**
3	16.90	(2.42 – 117.96)	.004**
4	3.50	(0.57 – 21.48)	.17
5 (reference)	--	--	--

Multiple options may apply. * p < .05; ** p <.01; *** p <.001

Table 2: EVD propensity analysis model: multivariate probability model of EVD placement



Predicted Probability of EVD Utilization	Outcome	EVD Utilization N=149 (25.5%) No N (%)	EVD Utilization N=149 (25.5%) Yes N (%)	Odds Ratio (95% CI) ref = EVD	P-Value
Propensity Analysis Model Stratification					
Low Prob < .25 N = 366	Mortality N (%)	63 (19.1%)	4 (16.0%)	.8 (.3 -2.4)	>.99
	mRS at Discharge Median (IQR)	3 (2 – 4)	4 (2 - 5)	--	.04*
Moderate .25 < Prob < .5 N = 89	Mortality N (%)	20 (36.4%)	9 (27%)	.7 (.3 – 1.7)	.46
	mRS at Discharge Median (IQR)	4 (2 – 5)	5 (4 – 5)	--	.02*
High Prob ≥ .5 N = 112	Mortality N (%)	11 (39.3%)	32 (39.0%)	1.0 (.4 – 2.4)	.27
	mRS at Discharge Median (IQR)	4 (2 – 5)	4 (3 – 5)	--	.33

*P <.05

Table 3: Patient outcomes stratification by multivariate propensity analysis model

Propensity Analysis

-- Odds of EVD utilization increased with basal ganglia involvement, increased IVH volume, and concurrent IVH, while utilization decreased with age and extensive ICH volume.

-- Excellent discriminability for EVD utilization was demonstrated (AUROC 0.88, RMcFadden = 0.35).

Outcomes

-- EVD utilization was associated with decreased odds of mortality (Moderate OR = 0.7, High OR = 0.6) as the probability of EVD utilization increased; however, significance was not reached (Table 1).

-- Among survivors, mRS at discharge was significantly higher in patients receiving an EVD in the lower EVD risk strata (4.0 vs. 5.0, p=0.006), but not different in the highest EVD risk strata.

Conclusions

-- The statistical propensity analysis model was able to accurately predict EVD utilization in ICH.

-- There was a trend towards decreased mortality associated with EVD utilization as probability for EVD increased.

-- EVD utilization was associated with significantly higher mRS for functional outcomes.