

Learning Objectives

To quantify the financial burden of ventriculostomy catheter-associated infections, including direct and indirect healthcare costs.

Introduction

Rates of external ventricular drain (EVD)-associated infections range broadly in the literature, from 1 - 40%. Nonetheless, ventriculostomy-associated infections (VAIs) are a significant cause of morbidity and portends an overall poor prognosis. VAIs have been correlated with increased length of hospital stay and a longer time requiring intensive care. Given the worse clinical outcomes and the greater use of hospital resources, we hypothesize that patients with VAIs have overall greater health care costs compared to non-infected patients.

Methods

Patients who underwent EVD placement at Mount Sinai Hospital between December 2010 and January 2016 were included in the study. Clinical records were retrospectively reviewed from the hospital’s electronic medical record, and healthcare cost data was obtained from the hospital’s finance department. Clinical information included demographics, details from the hospital course, and outcomes. Total costs, as well as direct/indirect and fixed/variable costs, were analyzed for every patient.

Results

Over the 6-year study period, 246 EVDs were placed in 243 patients with an overall infection rate of 9.9% (n=24). The median duration of external ventricular drainage for infected compared to non-infected patients was 19 and 9 days, respectively (p<0.0001). Median length of intensive care unit stay was also increased for patients with VAI (30 days), compared to non-infected patients (13 days). Total healthcare costs were significantly increased for infected versus non-infected patients (US\$ 168,629 versus US\$ 83, 919, p<0.0001). This trend was comparable for all other cost subtypes including fixed-direct (US\$ 9,973 vs. US\$ 5,079, p<0.001), fixed-indirect (US\$ 74,473 vs. US\$ 36,277, p<0.001), variable-direct (US\$ 76,700 vs. US\$ 36,870, p<0.001), and variable-indirect (US\$ 8,898 vs. US\$ 4,653, p<0.001). The percentage cost increases were 96%, 105%, 108%, and 91%, respectively.

Table 1. Characteristics of a single institution population undergoing EVD placement with and without infections			
	Not Infected (n=222)	Infected (n=24)	p-value
Age*	57 (44-66)	51 (44.5-62)	0.31
Charlson Comorbidity Index*	2 (1-4)	1 (0-2.5)	0.04
Sex (Female)	106 (47.75%)	9 (37.50%)	0.34
Uninsured (Yes)	80 (36.04%)	12 (50.00%)	0.18
	\$52,498 (\$42,818-\$70,322)	\$52,168 (\$44,933-\$80,141)	0.72
Median Household Income*			0.7
Indication for EVD			
ICH	55 (24.77%)	5 (20.83%)	
SAH	104 (46.85%)	12 (50.00%)	
Trauma	4 (1.80%)	0 (0.00%)	
Tumor	29 (13.06%)	3 (12.50%)	
Other	30 (13.51%)	4 (16.67%)	
Location of EVD Placement			0.24
Emergency Department	10 (4.52%)	2 (8.33%)	
Operating Room	49 (22.17%)	2 (8.33%)	
Neurosurgical Intensive Care Unit	133 (60.18%)	15 (62.50%)	
Radiology Department	4 (1.81%)	1 (4.17%)	
Unknown or Outside Hospital	25 (11.31%)	4 (16.67%)	
Bilateral EVD Placed	8 (3.60%)	7 (29.17%)	<0.0001
Prophylactic Antibiotics Received (Yes)	175 (79.55%)	20 (86.96%)	0.4
EVD Duration (Days)*	9 (5-14)	19 (13-29.5)	<0.0001
*continuous data are presented as median (interquartile range)			

Table 2. Outcomes of a single institution population undergoing EVD placement with and without infections			
	Not Infected (n=222)	Infected (n=24)	p-value
Modified Rankin Scale at Discharge			0.55
0	17 (7.69%)	2 (8.33%)	
1	21 (9.50%)	2 (8.33%)	
2	7 (3.17%)	0 (0.00%)	
3	14 (6.33%)	3 (12.50%)	
4	42 (19.00%)	4 (16.67%)	
5	55 (24.89%)	9 (37.50%)	
6	65 (29.41%)	4 (16.67%)	
ICU Length of Stay*	13 (8-20)	30 (18.5-51.5)	<0.0001
Total Length of Stay*	18 (12-27)	35.5 (24.5-64)	<0.0001
Total Cost*	\$83,919 (\$48,457-\$120,682)	\$168,629 (\$106,849-\$273,449)	<0.0001
Fixed Direct Costs**	\$5,079 (\$3,128-\$7,455)	\$9,963 (\$6,647-\$16,085)	<0.0001
Fixed Indirect Costs**	\$36,277 (\$20,561-\$51,252)	\$74,473 (\$43,837-\$124,348)	<0.0001
Variable Direct Costs**	\$36,870 (\$21,820-\$54,289)	\$76,700 (\$52,657-\$119,220)	<0.0001
Variable Indirect Costs**	\$4,653 (\$2,802-\$6,618)	\$8,898 (\$5,871-\$17,026)	<0.0001
*continuous data are presented as median (interquartile range); ^n for the not infected group equals 217			

Conclusions

The complications associated with ventricular catheter infection lead to significantly increased overall healthcare costs by approximately double. This takes into account direct costs of the healthcare system, as well as the indirect costs associated with morbidity and loss of productivity. Moving forward, prevention of ventriculostomy-associated infections remains of utmost importance to limit undue strain on the neurosurgical healthcare financial system.

References

1. Sonabend AM, Korenfeld Y, Crisman C, Badjatia N, Mayer SA, Connolly ES, Jr. Prevention of ventriculostomy-related infections with prophylactic antibiotics and antibiotic-coated external ventricular drains: a systematic review. Neurosurgery. 2011;68(4):996-1005.

2. Hoefnagel D, Dammers R, Ter Laak-Poort MP, Avezaat CJJ. Risk factors for infections related to external ventricular drainage. Acta neurochirurgica. 2008;150(3):209-214.

3. Lyke KE, Obasanjo OO, Williams MA, O'Brien M, Chotani R, Perl TM. Ventriculitis complicating use of intraventricular catheters in adult neurosurgical patients. Clin Infect Dis. 2001;33(12):2028-2033.