Volume-Outcome Relationships in Neurosurgery

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KEYWORDS

• Neurosurgery • Volume • Outcomes • Surgery

KEY POINTS

- For a variety of neurosurgical conditions, increasing surgeon and hospital volumes correlate with improved outcomes, such as mortality, complication rates, length of stay, hospital charges, and discharge disposition.
- Neurosurgeons can improve patient outcomes at the population level by changing practice and referral patterns to regionalize care for select conditions at high-volume specialty treatment centers.
- Individual practitioners should be aware of where they fall on the volume spectrum and understand the implications of their practice and referral habits on their patients.

INTRODUCTION

Evidence is mounting that patient morbidity and mortality rates decrease when high-volume physicians and centers perform certain medical or surgical procedures (**Tables 1** and **2**). These volume-outcome relationships (VORs) have been demonstrated for common procedures, such as hip and knee replacements, and more complex procedures, such as pancreaticoduodenectomy and abdominal aortic aneurysm repair. Data such as these have been used to support changes in the delivery of care, with centralization of patients and procedures at specialized centers in efforts to increase volumes and thereby improve overall patient outcomes.

During the past decade, neurosurgeons have begun to study the impact of surgeon and institutional volume on a variety of outcomes across the neurosurgical subspecialties. Positive relationships have been shown between higher volume and improved length of stay, mortality, complications, charges, and discharge dispositions. This article summarizes current evidence for VORs in neurosurgery to examine the basis for centralization of neurosurgical services. For each subspecialty (tumor, vascular, spine, pediatrics, functional, and neurotrauma), the literature for relevant studies is reviewed, the pertinent VORs that have been studied to date are summarized, and the implications of these data are discussed.

INTRACRANIAL TUMOR

Surgery for tumor treatment is among the most highly studied of the neurosurgical specialties. Multiple studies of patients with intracranial tumors have shown improved outcomes at higher-volume centers. Some look across the spectrum of tumors, whereas others concentrate the analyses on specific subsets of tumors.

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Table 1
Hospital caseload volume-outcome relationships

Specialty	Subspecialty	Author	Stratification	Volume Threshold	Mortality	Disposition	Length of Stay	Complications
Tumor	All	Long et al,[1] 2003	Dichotomous	>50/y	RR, 0.71; *P*<.05		6.8 vs 8.8 d; *P*<.001	
	All	Cowan et al,[2] 2003	Quartile	>29/y	OR, 0.58; 95% CI, 0.35–0.97; *P* = .04			
	All	Nuno et al,[3] 2012	Quintiles	>139/y	OR, 0.56; 95% CI, 0.37–0.83	OR, 0.71; 95% CI, 0.59–0.91	6.4 vs 8.0 d	
	Supratentorial primaries	Barker et al,[4] 2005						
		Craniotomy	Quintile	>41/y	OR, 0.75; 95% CI, 0.62–0.90; *P* = .003	OR, 0.77; 95% CI, 0.70–0.85; *P*<.001	NS	OR, 1.67; 95% CI, 1.13–2.45; *P* = .009
		Biopsy	Quintile	>11/y	OR, 0.54; 95% CI, 0.35–0.83; *P* = .006	OR, 0.67; 95% CI, 0.56–0.80; *P*<.001	19% shorter; *P*<.001	
		Trinh et al,[5]	Quartile/ decile	>35/y	OR, 0.76; 95% CI, 0.63–0.90; *P*<.001	OR, 1.29; 95% CI, 1.21–1.37; *P*<.01		OR, 0.93; 95% CI, 0.97–0.99; *P* = .040
	Metastasis	Barker,[6] 2004	Quintile	>17/y	OR, 0.79; 95% CI, 0.59–1.03; *P* = .09	OR, 0.75; 95% CI, 0.65–0.86		
	Transsphenoidal pituitary tumors	Barker et al,[7] 2003	Quartile	>24/y	OR, 0.54; CI, 0.31–0.95; *P* = .03	OR, 0.74; 95% CI, 059–0.92; *P* = .007	*P* = .02	OR, 0.77; 95% CI, 0.61–0.97; *P* = .03
	Meningioma	Curry et al,[8] 2010	Quartile	>17/y	OR, 0.74; 95% CI, 0.59–0.93	OR, 0.71; 95% CI, 0.62–0.80		
		Ambekar et al,[9] 2013	Quartile	>16/y	OR, 0.5; 95% CI, 0.38–0.66; *P*<.001	OR, 0.8; 95% CI, 0.74–0.86; *P*<.001		
	Acoustic neuroma	Barker et al,[10] 2003	Quartile	>36/y	NS	OR, 0.47; 95% CI, 0.37–0.58; *P*<.001	*P* = .01	OR, 0.75; CI, 0.64–0.89, *P*<.001
	Chordoma	Jones et al,[11] 2014	Dichotomous	>40	HR, 0.49; 95% CI, 0.28–0.86; *P* = .013			