Quality Improvement and Value Driven Outcomes as Part of Resident Education

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Introduction

- ACGME common program requirements

VI.A.1.a)	Patient Safety	
VI.A.1.a).(1)	Culture of Safety	
	A culture of safety requires continuous identification of vulnerabilities and a willingness to transparently deal with them. An effective organization has formal mechanisms to assess the knowledge, skills, and attitudes of its personnel toward safety in order to identify areas for improvement.	
VI.A.1.a).(1).(a)		The program, its faculty, residents, and fellows must actively participate in patient safety systems and contribute to a culture of safety. (Core)

VI.A.1.a).(2) Education on Patient Safety

Programs must provide formal educational activities that promote patient safety-related goals, tools, and techniques. (Core)

VI.A.1.a).(3).(b) Residents must participate as team members in real and/or simulated interprofessional clinical patient safety activities, such as root cause analyses or other activities that include analysis, as well as formulation and implementation of actions. (Core)

VI.A.1.b).(3) Engagement in Quality Improvement Activities

Experiential learning is essential to developing the ability to identify and institute sustainable systems-based changes to improve patient care.

VI.A.1.b).(3).(a) Residents must have the opportunity to participate in interprofessional quality improvement activities. (Core)

VI.A.1.b).(3).(a).(i) This should include activities aimed at reducing health care disparities. (Detail)

VI. The Learning and Working Environment

Residency education must occur in the context of a learning and working environment that emphasizes the following principles:

- *Excellence in the safety and quality of care rendered to patients by residents today*
- *Excellence in the safety and quality of care rendered to patients by today's residents in their future practice*

VI.A.1.b).(1).(a)	Residents must receive training and experience in quality improvement processes, including an understanding of health care disparities. (Core)

VI.A.1.b).(1)	Education in Quality Improvement *A cohesive model of health care includes quality-related goals, tools, and techniques that are necessary in order for health care professionals to achieve quality improvement goals.*

Understanding Complications

Complications in Endovascular Neurosurgery: Critical Analysis and Classification

Vijay M. Ravindra[1], Marcus D. Maru[1], Min S. Park[1], Craig Kilburg[1], Christopher J. Moran[2], Robin L. Hardesty[2], William T. Couldwell[3], Philipp Taussky[3]

Table 1. Four Categories of Complications in Endovascular Neurosurgery and Examples of Each

Mechanical Complications	Technical Complications	Judgment Errors	Critical Events
Failure in device deployment Catheter malfunction Wire breakage Closure device failure Coil malfunction Groin hematoma (failure of closure device)	Failure to fully deploy flow-diverting device Failure to recognize embolization into unintended vessels Asymptomatic air emboli Retroperitoneal hemorrhage from a high femoral artery puncture Vessel dissection Coil misplacement Groin hematoma (poor deployment of closure device)	Patient selection error Overpacking or underpacking of aneurysm Inadequate coiling of aneurysm resulting in re-rupture Poor selection of adequate equipment	Urinary tract infection Contrast media reactions Groin hematoma Radiation effects Acute coronary syndromes Groin site infections Hemorrhagic complications caused by antiplatelet or anticoagulation therapy Thromboembolic complications

World Neurosurg 95:1-8, 2016

JNS

CLINICAL ARTICLE

Defining a new neurosurgical complication classification: lessons learned from a monthly Morbidity and Mortality conference

Yair M. Gozal, MD, PhD, Erinç Aktüre, MD, Vijay M. Ravindra, MD, MSPH, Jonathan P. Scoville, MD, Randy L. Jensen, MD, PhD, William T. Couldwell, MD, PhD, and Philipp Taussky, MD

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"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."

JNS epub January 18, 2019

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Traditional M and M conference

- Complication acknowledgement vs root cause analysis
- Don’t recognize underlying system errors
- Lack action
- Each generation repeats same mistakes
- Surgical complications
  - Lacks standardization
  - No concensus definition
  - Lacks scientific framework

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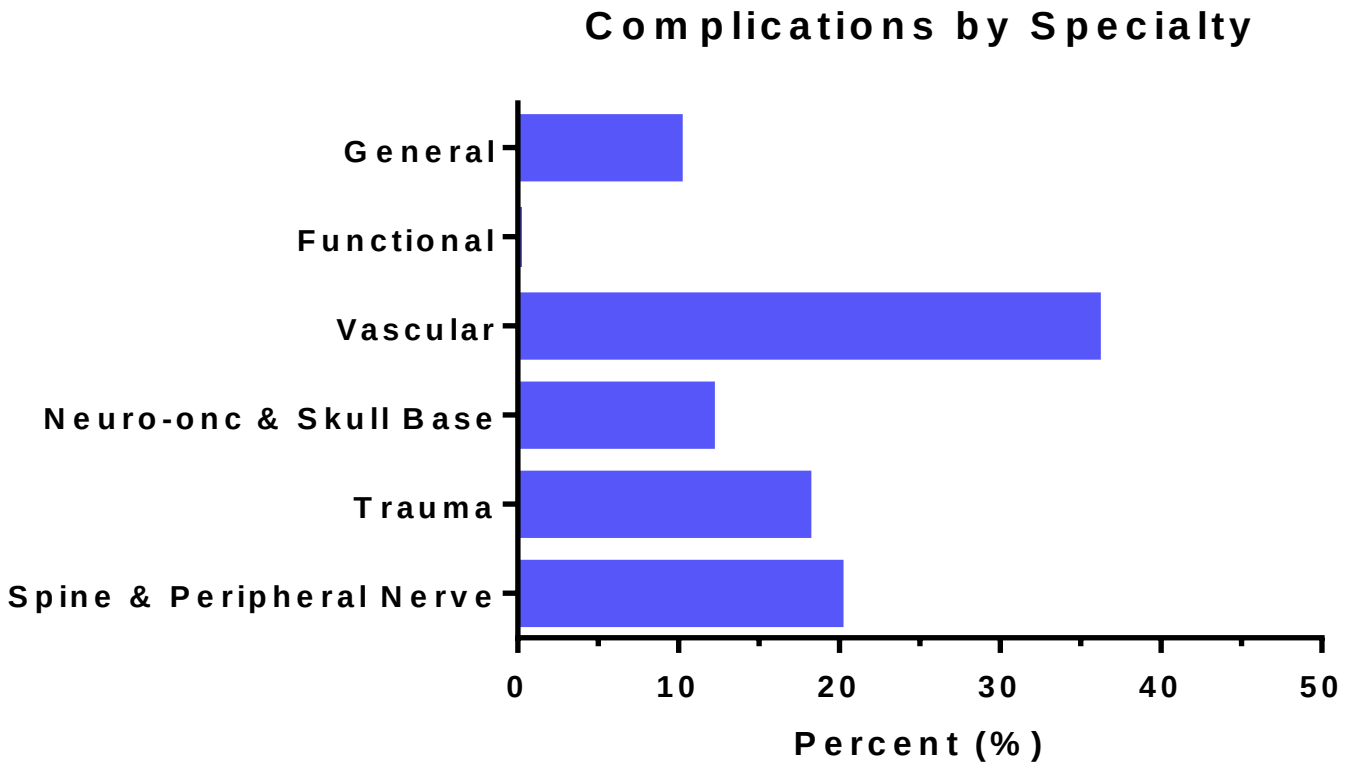
New neurosurgery-based system

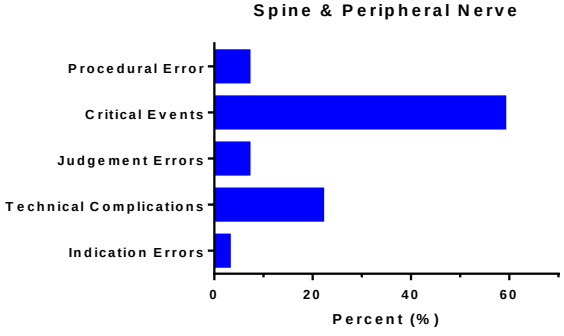
- Complications defined as any deviation from a normal postoperative course
- Sequelae were defined as after-effect of surgery
- Surgery may be well executed but may not achieve its purpose, is hence a ‘failure to cure”
- Importance of errors with asymptomatic consequence
- Quality measures and improvement efforts depend on honest assessment of complications

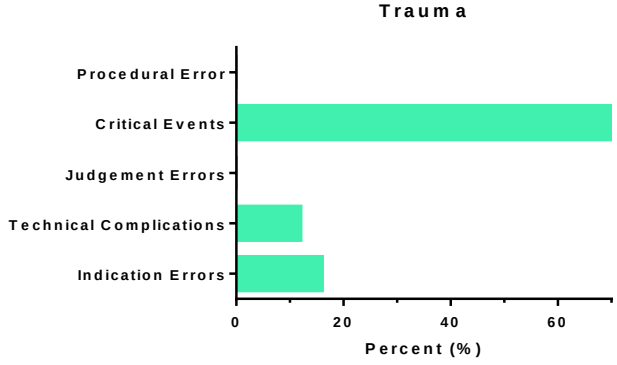
INDICATION ERROR	TECHNICAL COMPLICATIONS	JUDGMENT ERRORS	CRITICAL EVENTS	PROCEDURAL ERRORS
• Surgical risks exceed benefits • Futile surgery • Poor patient selection • Surgery indicated, but not performed	• Any technical mishap • Screw misplacement • Unintended residual aneurysm post clip/coil • Unintended injury to brain, spinal cord, nerves, blood vessels	• Poor approach selection • Poor position selection • Poor equipment selection • Over- or under-aggressive treatment	• Unintended unavoidable events • Postop hematoma • Postop wound infection • New MI, PE, DVT • New strokes not due to other causes	• Any operative discipline break down • No time-out • Wrong site surgery • Retained foreign body • Omission of preop abx

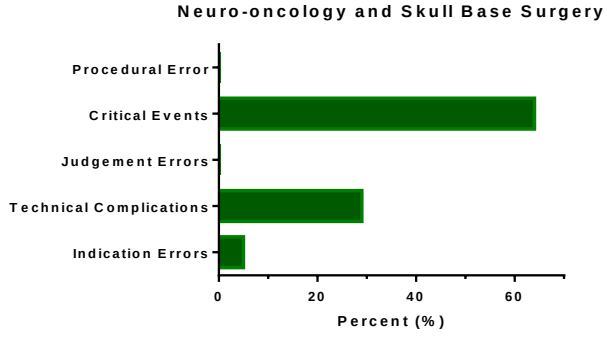
12 month analysis of neurosurgical M & M

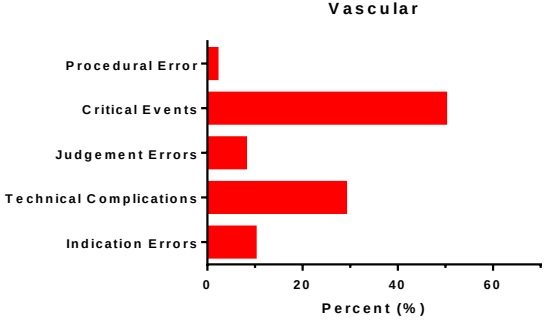
- **Total of 133 cases presented and analyzed**

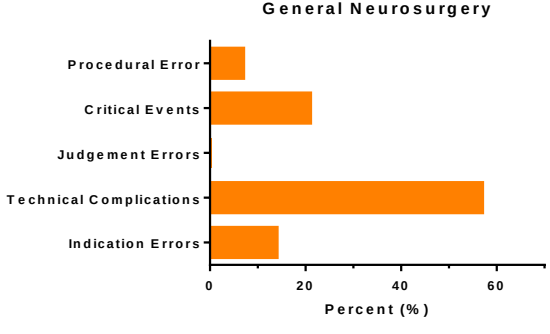


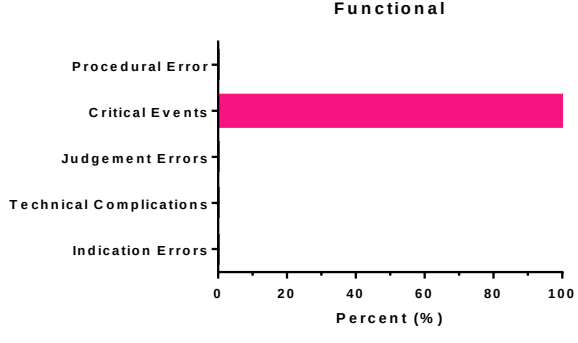

Spine & Peripheral Nerve
Procedural Error
Critical Events
Judgement Errors
Technical Complications
Indication Errors
0
20
40
60
Percent (%)


Trauma
Procedural Error
Critical Events
Judgement Errors
Technical Complications
Indication Errors
0
20
40
60
Percent (%)


Neuro-oncology and Skull Base Surgery
Procedural Error
Critical Events
Judgement Errors
Technical Complications
Indication Errors
0
20
40
60
Percent (%)


Vascular
Procedural Error
Critical Events
Judgement Errors
Technical Complications
Indication Errors
0
20
40
60
Percent (%)


General Neurosurgery
Procedural Error
Critical Events
Judgement Errors
Technical Complications
Indication Errors
0
20
40
60
Percent (%)


Functional
Procedural Error
Critical Events
Judgement Errors
Technical Complications
Indication Errors
0
20
40
60
80
100
Percent (%)

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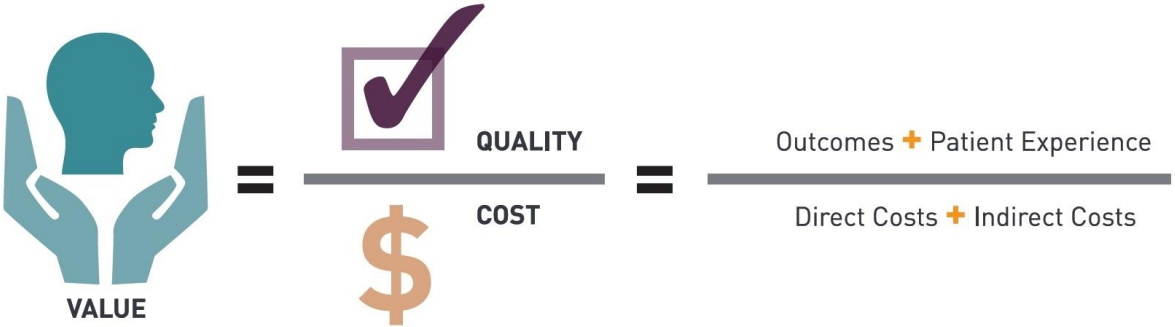
CONCLUSIONS

- Categorization allows for uniform and scientific analysis of complications
- Categorization analysis can reveal weaknesses
  - high number of indication errors in vascular surgery led to vascular indication conference
- Categorization analysis can reveal strengths
  - no indication errors in spine (presence of spine indication conference)
- Limitations include subjective interpretation and reporting. No severity scoring and no preventability scoring

VALUE DRIVEN OUTCOMES

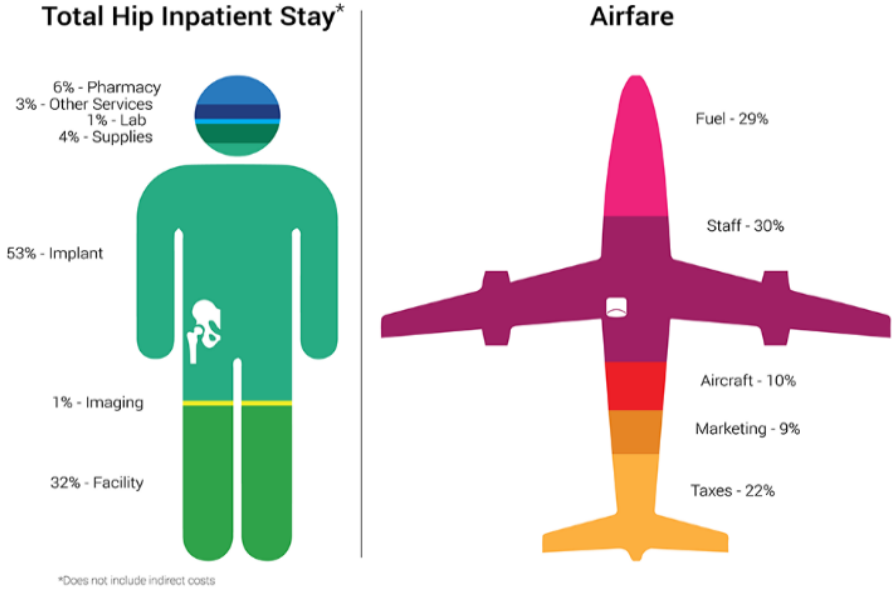


What is Value Driven Outcomes (VDO)?

VDO is a reporting tool that allocates clinical care costs and quality measures at the level of individual patient encounters, and by department, physician, diagnosis, and procedure.

VDO database

- Measures true cost of care, not charges or revenues as in many other prior studies
- Method: Divides general hospital cost ledger by time-based or unit-based value costs for each patient and encounter
- Strengths
  - True cost database
  - Itemized per patient, procedure and provider
  - Real-time information as costs change and can be retrospectively analyzed
- Limitations
  - Unable to account for professional fees
  - Limited accounting of outpatient cost



VDO breaks down the cost of treatment similarly to how cost is accounted for in industry

Kawamoto et al. J Am Med Inform Assoc. 2015; Lee et al. JAMA 2016

NEUROSURGICAL FOCUS

Neurosurg Focus 44 (5):E3, 2018

Analysis of cerebrovascular aneurysm treatment cost: retrospective cohort comparison of clipping, coiling, and flow diversion

*Spencer Twitchell, BS, Hussam Abou-Al-Shaar, MD, Jared Reese, BS, Michael Karsy, MD, PhD, MSc, Ilyas M. Eli, MD, Jian Guan, MD, Philipp Taussky, MD, and William T. Couldwell, MD, PhD

Department of Neurosurgery, Clinical Neurosciences Center, University of Utah, Salt Lake City, Utah

- N=469 patients, unruptured and ruptured aneurysms
- 273 clipped, 102 coiled, 139 flow diversion

- Costs were primarily driven by facility costs and supplies/implants
- Coiling cost 1.5X clipping
- Flow diverters cost 1.2X clipping

Results

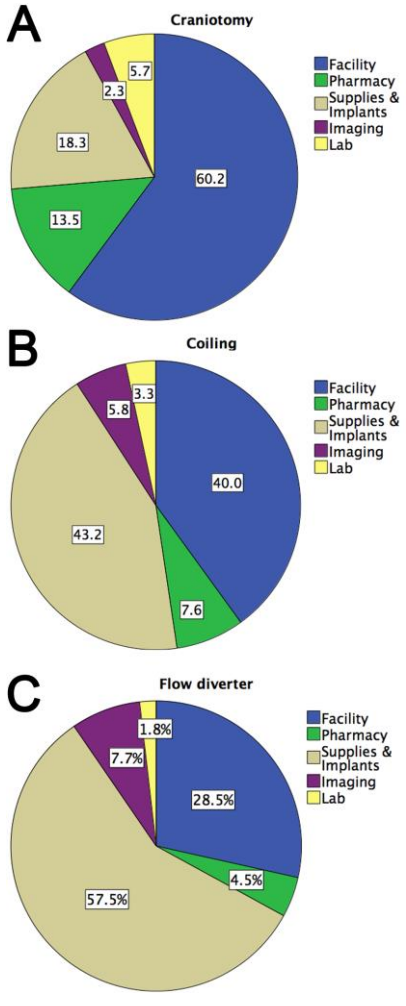


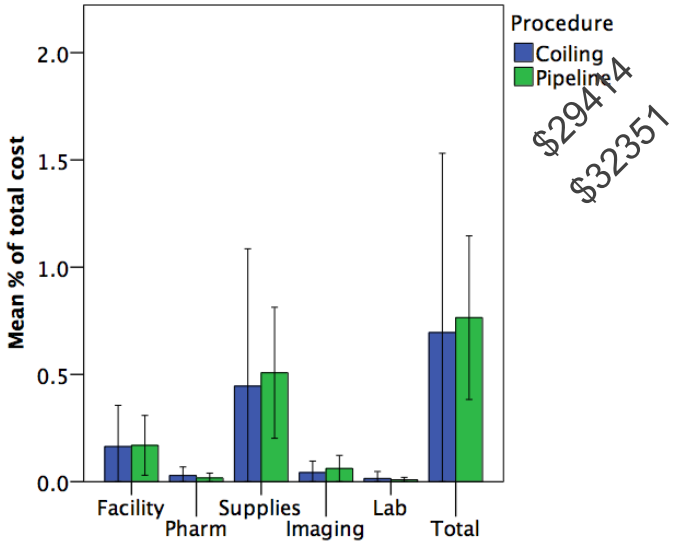
TABLE 2. Univariate and multivariable analysis of factors affecting cost

Cost Factor	Univariate Standardized β	Univariate p Value	Multivariable Standardized β	Multivariable p Value
Aneurysm location	−0.04	0.4	−0.03	0.5
Rupture status	−0.5	0.0001	−0.4	0.0001
Procedure type	0.08	0.06	0.3	0.0001
Sex	0.04	0.4	0.05	0.2
ASA grade	0.4	0.0001	0.2	0.0001
Discharge disposition	0.5	0.0001	0.3	0.0001
Yr of operation	0.2	0.0001	0.2	0.0001

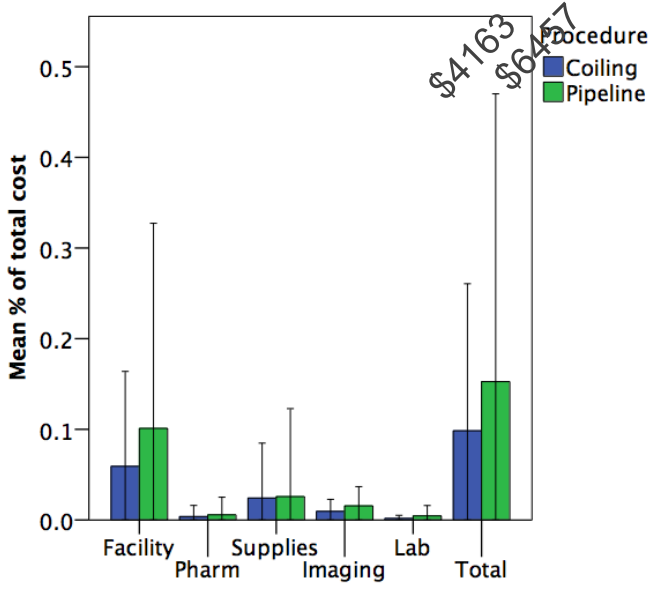
For the entire multivariable model: $R^2 = 0.65$, $p = 0.0001$.

- Facility costs accounted for most of clipping costs
- Supplies and implants accounted for most of coiling and flow diverter costs
- Multivariable linear regression showed that rupture status, surgical procedure type, ASA grade, discharge disposition and year impacted cost
- Procedure type and discharge disposition impacted cost the most

Results



Admission costs



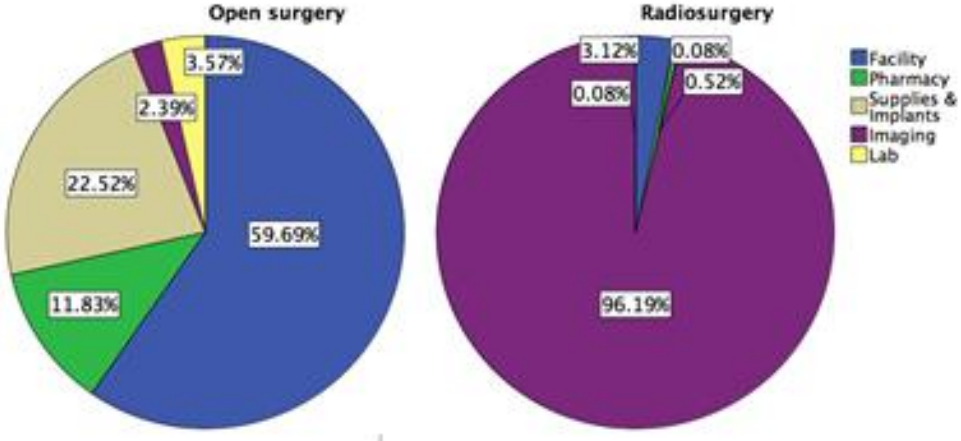
Followup costs

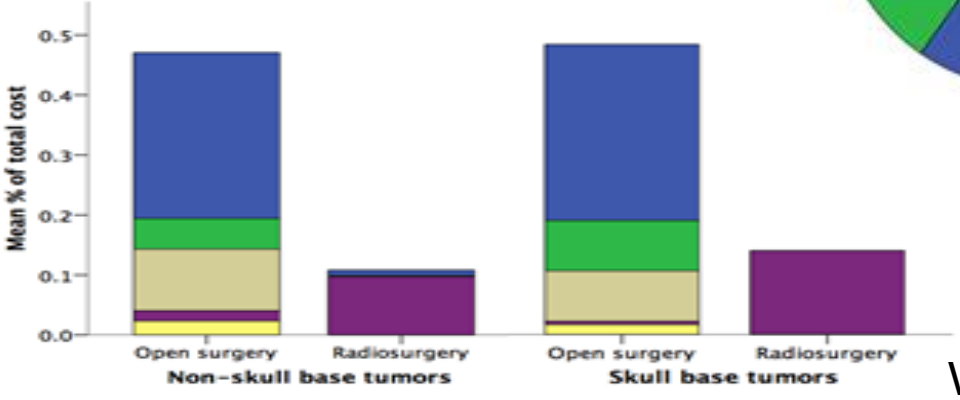
- No difference in admission costs between coiling and PED
- No difference in followup costs between coiling and PED

Assessment of Costs in Open Microsurgery and Stereotactic Radiosurgery for Intracranial Meningiomas

Hussam Abou-Al-Shaar, Mohammed A. Azab, Michael Karsy, Jian Guan, William T. Couldwell, Randy L. Jensen

Cost Drivers

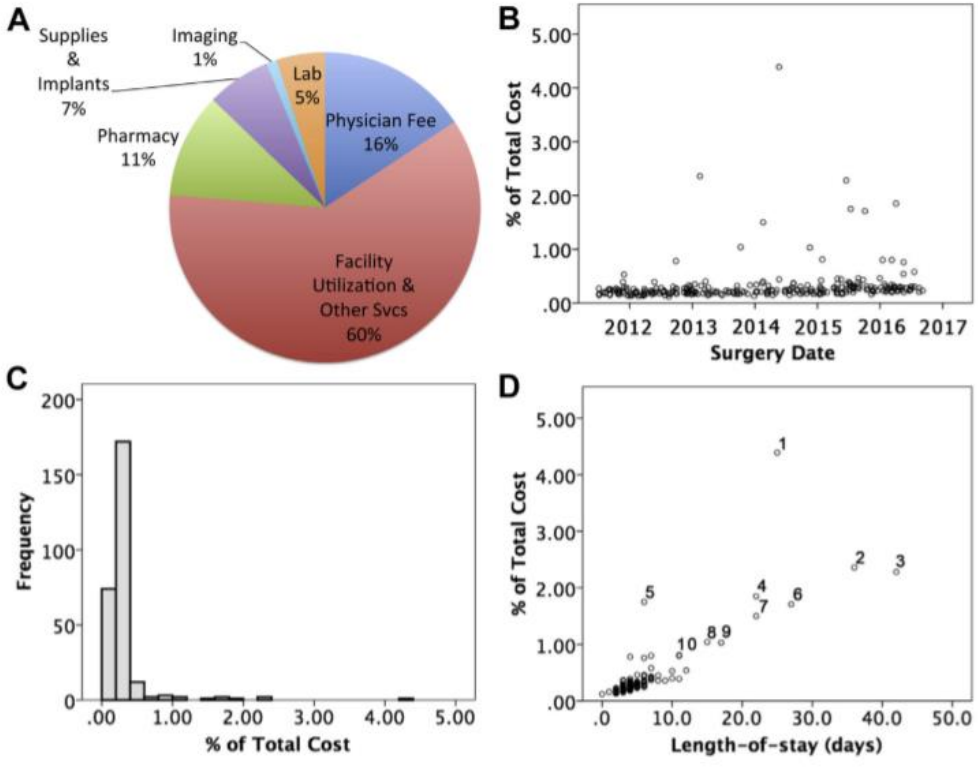




World Neurosurg Nov 119:357-365, 2018

Assessment of Cost Drivers in Transsphenoidal Approaches for Resection of Pituitary Tumors Using the Value-Driven Outcome Database

Michael Karsy, Andrea A. Brock, Jian Guan, Erica F. Bisson, William T. Couldwell



- 272 patients who underwent transsphenoidal resections of pituitary adenomas (July 2012-Sept 2016)
- Mean age 51.5 years
- Mean Length of stay 4 days

- Cost predominantly due to **facility** charges
- **Top 10 outlier** cost patients accounted for **18.7%** of the total cost of the group

Patient-Level Factors Influencing Hospital Costs and Short-Term Patient-Reported Outcomes After Transsphenoidal Resection of Sellar Tumors

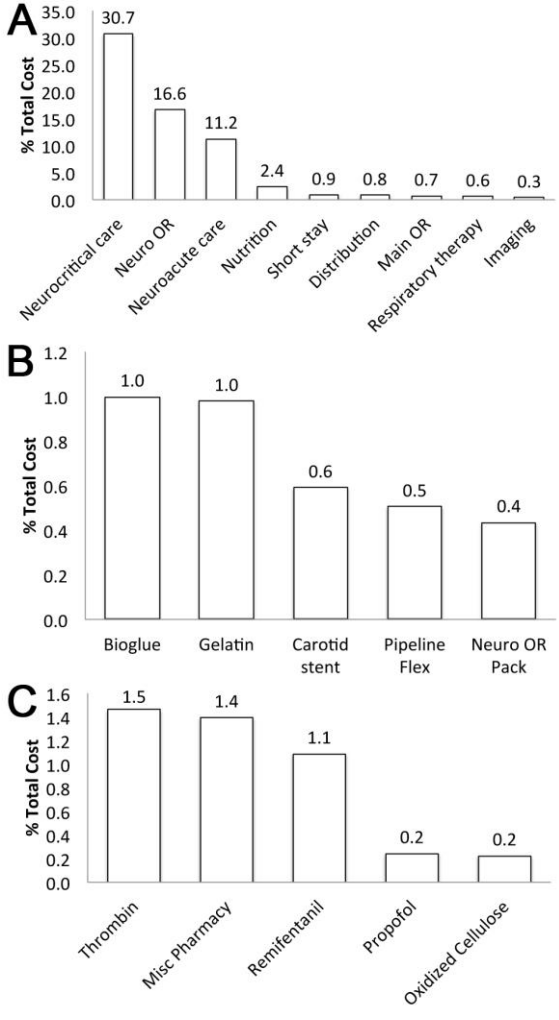
Jian Guan, MD
Michael Karsy, MD, PhD
Erica F. Bisson, MD, MPH
William T. Couldwell, MD, PhD

BACKGROUND: Identifying which factors influence treatment costs of transsphenoidal surgery for removal of sellar lesions can be complex.
OBJECTIVE: To identify which patient-level factors are associated with higher costs and evaluate the relationship between expenditures and short-term patient-reported outcomes.

TABLE 3. Multivariable Analysis Comparing Low-Cost and High-Cost Cohorts

Variable	OR	95% CI	*P* value[a]
Tumor type			.084
Nonfunctional	Ref	Ref	n/a
Growth hormone	3.92	0.15-102.46	.412
Prolactin	3.54	0.28-44.06	.327
ACTH	86.34	3.43-2176.42	**.007**
Other	1.19	0.05-26.69	.914
Tumor size (mm)	1.13	1.01-1.28	**.037**
Complications[b] (%)	14.98	2.21-101.68	**.006**
1-mo EQ-5D change	0.004	0.000-1.77	.076

- 117 patients who underwent treatment of sellar tumors (e.g. pituitary adenoma or other [Rathke cleft cyst, craniopharyngioma, germinoma])
- 77 (65.8%) patients showed stable to improved EQ-5D scores at 1 month followup
- **ACTH secreting tumors**, **larger tumors** and patients with **complications** were independent predictors of increased cost



Results

- Top 3 costs
  - neurosurgical intensive care unit 30.7%
  - operating room 16.6%
  - Neuro Acute Care unit (floor) 11.2%

Assessment of costs in open surgery and stereotactic radiosurgery for vestibular schwannomas

Hussam Abou-Al-Shaar, MD, Mohammed A. Azab, MD, Michael Karsy, MD, PhD, MSc, Jian Guan, MD, Gmaan Alzhrani, MD, Yair M. Gozal, MD, PhD, Randy L. Jensen, MD, PhD, and William T. Couldwell, MD, PhD

Department of Neurosurgery, Clinical Neurosciences Center, University of Utah, Salt Lake City, Utah

J Neurosurg Oct 1 1-8, 2018

Evaluation of cost and survival in intracranial gliomas using the Value Driven Outcomes database: a retrospective cohort analysis

***Herschel Wilde, BS,[1] Mohammed A. Azab, MD,[1] Abdullah M. Abunimer, MD,[2] Hussam Abou-Al-Shaar, MD,[3] Michael Karsy, MD, PhD, MSc,[1] Jian Guan, MD,[1] Sarah T. Menacho, MD,[1] and Randy L. Jensen, MD, PhD[1]**

[1]Department of Neurosurgery, Clinical Neurosciences Center, University of Utah, Salt Lake City, Utah; [2]Department of Neurosurgery, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts; and [3]Department of Neurosurgery, Hofstra Northwell School of Medicine, Manhasset, New York

J Neurosurg Mar 29:1-11, 2019

Analysis of Treatment Cost Variation Among Multiple Neurosurgical Procedures Using the Value-Driven Outcomes Database

Jared C. Reese[1], Spencer Twitchell[1], Herschel Wilde[1], Mohammed A. Azab[2], Jian Guan[2], Michael Karsy[2], William T. Couldwell[2]

- 1997 patients (mean age 54.6 years, mean length of stay 4.0 days)
- Compares cost across vestibular schwannoma, pituitary adenoma, meningioma, glioma, lumbar fusion, ACDF and aneurysm treatment

Table 1. Patient Demographics

Variable	Total	Vestibular Schwannoma	Pituitary Adenoma	Meningioma	Glioma	Lumbar	ACDF	Aneurysm	*P*
Number of patients	1997	147	272	230	288	274	465	321	
Age, years, mean ± SD	54.6 ± 14.5	55.7 ± 15.4	51.1 ± 17.7	54.5 ± 14.9	54.0 ± 15.8	58.8 ± 12.4	53.4 ± 12.1	56.0 ± 13.5	<0.0001*
Male sex, number (%)	903 (45.2)	76 (51.7)	124 (45.6)	70 (30.4)	160 (55.6)	128 (46.7)	250 (53.8)	95 (29.6)	<0.0001
LOS, days, mean ± SD	4.0 ± 4.4	4.3 ± 5.7	4.4 ± 4.3	4.6 ± 4.5	5.6 ± 5.6	4.5 ± 1.6	1.5 ± 1.2	4.5 ± 5.6	<0.0001†
ASA classification, number (%)									<0.0001
Unknown	189 (9.5)	48 (32.7)	7 (2.6)	28 (12.2)	4 (1.4)	9 (3.3)	0 (0.0)	81 (25.2)	
I: Healthy	85 (4.3)	12 (8.2)	9 (3.3)	3 (1.3)	4 (1.4)	14 (5.1)	39 (8.4)	4 (1.2)	
II: Mild	930 (46.6)	63 (42.9)	135 (49.6)	81 (35.2)	83 (28.8)	175 (63.9)	309 (66.5)	84 (26.2)	
III: Severe	724 (36.3)	23 (15.6)	118 (43.4)	106 (46.1)	175 (60.8)	74 (27.0)	109 (23.4)	119 (37.1)	
IV: Incapacitating	68 (3.4)	1 (0.7)	3 (1.1)	12 (5.2)	22 (7.6)	2 (0.7)	8 (1.7)	20 (6.2)	
V: Moribund	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	
VI: Brain-dead	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Total cost, mean ± SD % of total	0.050 ± 0.046	0.039 ± 0.025	0.03 ± 0.036	0.051 ± 0.051	0.051 ± 0.038	0.063 ± 0.017	0.03 ± 0.009	0.089 ± 0.077	<0.0001

ACDF, anterior cervical discectomy and fusion; LOS, length of stay; ASA, American Society of Anesthesiologists.

*Age was significantly different between vestibular schwannoma and pituitary adenoma ($P = 0.03$), pituitary adenoma and lumbar fusion ($P = 0.0001$), pituitary adenoma and aneurysm ($P = 0.001$), lumbar fusion and ACDF ($P = 0.0001$), and lumbar fusion and glioma ($P = 0.001$) (Tukey post hoc analysis).

†LOS was significantly different between ACDF and other categories ($P < 0.0001$, Tukey post-hoc analysis).

World Neurosurgery Mar 11: S1878-8750, 2019

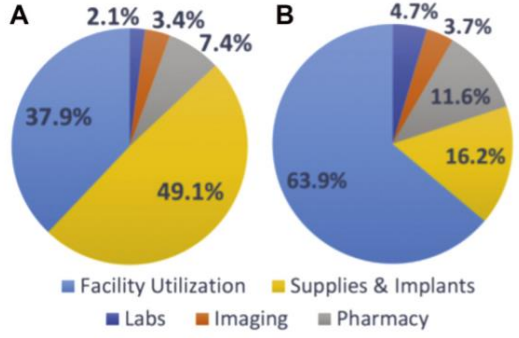
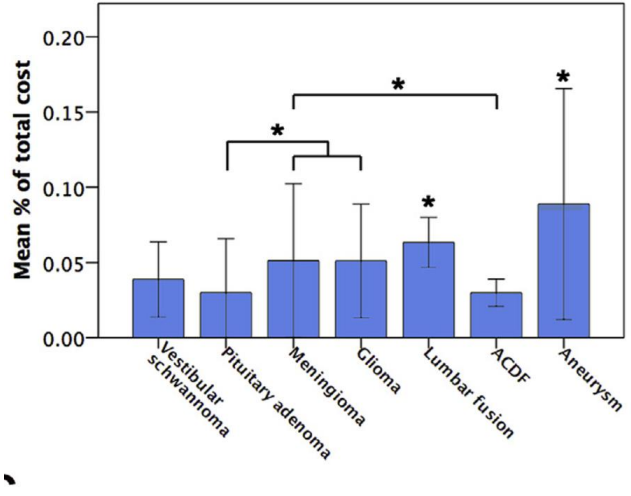
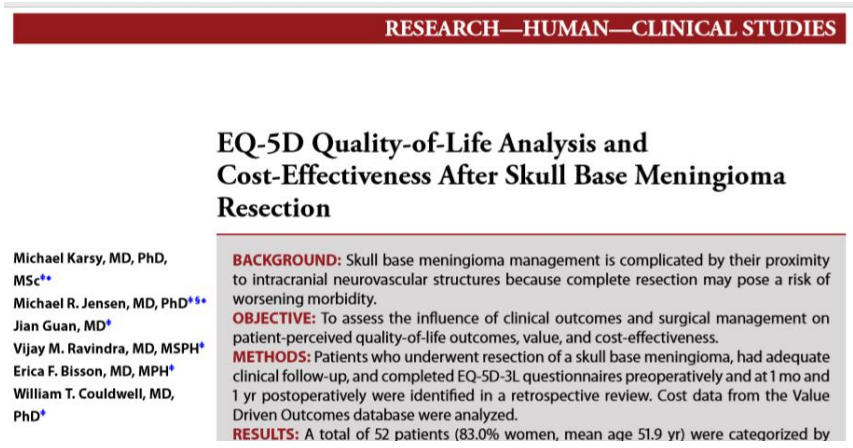


Figure 3. Cost subtotals for different neurosurgical procedural categories. Cost distribution across major categories: (**A**) Hardware cases (anterior cervical discectomy and fusion, lumbar fusion, aneurysm treatment); (**B**) tumor cases (vestibular schwannoma, pituitary adenoma, meningioma, glioma).



- Cost drivers depend on case type:
  - Hardware (i.e. vascular and spine)
  - Facility costs (i.e. tumors)
  - Length of stay (all)
  - Complications (all)
- Treatment costs amounts and variability differ depending on case type



RESEARCH—HUMAN—CLINICAL STUDIES

EQ-5D Quality-of-Life Analysis and Cost-Effectiveness After Skull Base Meningioma Resection

Michael Karsy, MD, PhD, MSc[†*]
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Jian Guan, MD[†]
Vijay M. Ravindra, MD, MSPH[†]
Erica F. Bisson, MD, MPH[†]
William T. Couldwell, MD, PhD[†]

BACKGROUND: Skull base meningioma management is complicated by their proximity to intracranial neurovascular structures because complete resection may pose a risk of worsening morbidity.
OBJECTIVE: To assess the influence of clinical outcomes and surgical management on patient-perceived quality-of-life outcomes, value, and cost-effectiveness.
METHODS: Patients who underwent resection of a skull base meningioma, had adequate clinical follow-up, and completed EQ-5D-3L questionnaires preoperatively and at 1 mo and 1 yr postoperatively were identified in a retrospective review. Cost data from the Value Driven Outcomes database were analyzed.
RESULTS: A total of 52 patients (83.0% women, mean age 51.9 yr) were categorized by

- 52 patients with resection of skull base meningioma from Aug 2012 to July 2016 with acquired EQ-5D and cost measures
- Mean age 51.9 years; mean length of stay 5.1 days
- Most common grade I meningioma (92.3%)
- Most patients presented with vision changes (61.5%) followed by headache (36.5%) and new cranial nerve deficits (30.8%)
- Most tumors involved the tuberculum sellae (19.2%) followed by petroclival (15.4%) and sphenoid wing (15.4%)
- Simpson grade I-III resection achieved in 53.8% of patients
- Surgical complications included CSF leak (7.7%), unexpected cranial nerve injury (1.9%), infection (1.9%), stroke (1.9%) and UTI (1.9%)

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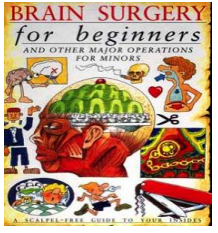
Summary of VDO projects in neurosurgery

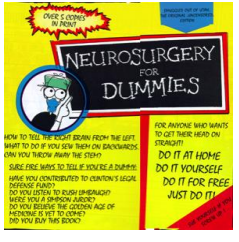
- Completed publications: 15
- Submitted manuscripts: 2
- In progress manuscripts: 1
- Regional and national conferences: 8
- Poster presentations: 13

- Topics
  - Pathology: sellar tumors, pituitary adenomas, skull base meningiomas, gliomas, vestibular schwannomas, aneurysms, cervical and lumbar fusion, spine injury rehabilitation
  - Treatment modalities: open surgery, endovascular surgery, radiosurgery

Conclusions

- VDO database has been instrumental in understanding health care cost at the University of Utah
- May be able to mitigate cost using strategies such as stratifying low-risk patients to an intermediate care unit and reducing length of stay
- Cost drivers differ for various neurosurgical disease
  - one size fits all approach towards reducing costs will not likely be successful
- Costs are highly variable in some diseases (e.g. aneurysms) compared with others (e.g. spine), suggesting different strategies are needed for cost control
- Neurosurgeons will be important to study the results of cost and cost control measures as they understand the issues potentially impacting patient outcomes and cost variability





Thank you
Questions?