Assessing the cost of contemporary pituitary care

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Object. Knowledge of the costs incurred through the delivery of neurosurgical care has been lagging, making it challenging to design impactful cost-containment initiatives. In this report, the authors describe a detailed cost analysis for pituitary surgery episodes of care and demonstrate the importance of such analyses in helping to identify high-impact cost activities and drive value-based care.

Methods. This was a retrospective study of consecutively treated patients undergoing an endoscopic endonasal procedure for the resection of a pituitary adenoma after implementation and maturation of quality-improvement initiatives and the implementation of cost-containment initiatives.

Results. The cost data pertaining to 27 patients were reviewed. The 2 most expensive cost activities during the index hospitalization were the total operating room (OR) and total bed-assignment costs. Together, these activities represented more than 60% of the cost of hospitalization. Although value-improvement initiatives contributed to the reduction of variation in the total cost of hospitalization, specific cost activities remained relatively variable, namely the following: 1) OR charged supplies, 2) postoperative imaging, and 3) use of intraoperative neuromonitoring. These activities, however, each contributed to less than 10% of the cost of hospitalization. Bed assignment was the fourth most variable cost activity. Cost related to readmission/reoperation represented less than 5% of the total cost of the surgical episode of care.

Conclusions. After completing a detailed assessment of costs incurred throughout the management of patients undergoing pituitary surgery, high-yield opportunities for cost containment should be identified among the most expensive activities and/or those with the highest variation. Strategies for safely reducing the use of the targeted resources, and related costs incurred, should be developed by the multidisciplinary team providing care for this patient population.

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KEY WORDS • pituitary adenoma • value • cost • quality •
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ONE of the provisions of the Affordable Care Act (ACA) is a new payment paradigm that prioritizes reimbursement on the basis of “value” rather than the current fee-for-service model. In a recent survey, 82% of health plans considered the development of new payment models a “major priority” for their organization.⁸ The physician value-based payment modifier was created to provide for differential payment to a physician or group of physicians on the basis of the quality of care delivered and the cost to deliver this care.^{4,23} The Centers for Medicare and Medicaid Services has based its assessment of the quality composite on the Physician Quality Reporting System, which contains more than 200 measures, only a small number of which apply to neurosurgeons. Accurate

assessment of the modifier’s cost composite is even more challenging. The ACA has adopted 2 core cost measures: 1) total per-capita costs based on standardized Medicare payments, and 2) total costs for beneficiaries with specific chronic conditions. National benchmarks will be established for not only the quality of care composite but also the cost of care delivery composite.

The goal for neurosurgery as a specialty is to deliver the best quality of care for patients with neurosurgical conditions. Over the last decade, neurosurgeons, their institutions, and their health systems have engaged in various initiatives to report quality measures to local and national organizations.^{7,13} However, efforts to truly understand the costs that are incurred through the delivery of this optimal care have been lagging. Physician involvement is important; approximately 60% of health care costs are determined or influenced by clinicians.^{1,3} Conversely, in a recent survey to assess the attitudes of physicians toward

Abbreviations used in this paper: ACA = Affordable Care Act; ICU = intensive care unit; IOM = intraoperative monitoring; LOS = length of stay; OR = operating room; POD = postoperative day.

their perceived role in addressing health care costs, only 36% reported that practicing physicians have a “major responsibility” for reducing health care costs.²²

In this report, we describe a detailed cost analysis specifically for surgical episodes of care for an endoscopic endonasal procedure for the resection of a pituitary adenoma after value-improvement initiatives were launched in 2012. We introduce a cost-containment prioritization matrix as a tool for guiding the selection of high-yield targets for cost-containment initiatives. Finally, we discuss the current limitations of costing systems and present potential solutions.

Methods

Patient Populations

All patients having their operation for the first time by the director of the Pituitary Tumor Program (M.B.) for a pituitary adenoma via a purely endoscopic endonasal approach at Ronald Reagan UCLA Medical Center, with available cost data, were considered for this study. The study population included all consecutively treated patients who had the operation between January 2012 and July 2012, representing the era after the implementation and maturation of quality-improvement initiatives and the implementation of cost-containment initiatives in the Pituitary Tumor Program. This research was approved by our local institutional review board.

Clinical Data Collection

The patients’ hospital records from the Ronald Reagan UCLA Health System, including clinical notes (outpatient and inpatient), radiographic images, and operative notes, were reviewed. Outcome measures spanning each patient’s entire surgical episode of care were assessed using the outcome hierarchy methodology by Porter.^{18,19} Early outcomes, specifically those related to the process of recovery, were identified through review of operative reports and postoperative inpatient and outpatient clinical notes. Time to recovery included the total time in the operating room (OR), total surgical time, recovery room length of stay (LOS), intensive care unit (ICU) LOS, floor LOS, and total LOS. Disutility of care included the need for intraoperative blood transfusions, the occurrence of surgery-related complications, readmission within 30 days, and reoperation within 30 days.

Cost Data Collection

Activity-based costing data were extracted from the Decision Support-Enterprise Performance Systems, Inc. (EPSi), in collaboration with our finance department. With this costing methodology, the activity cost of care was calculated by adding the cost of all activities and resources.¹⁶ As recommended in other cost models, the total cost values (including direct and indirect costs) were used, not estimates of cost. Therefore, the total cost included the costs that arose directly from the delivery of care (direct cost) and those incurred by administrative expenses and overhead.

In addition to the total cost of the index hospital-

ization, costs for the individual elements of care were captured. The major costs consisted of: 1) total bed-assignment cost (including nursing and support personnel time and bed facility base for the ICU and the floor unit, excluding other activity costs such as those for pharmacy, imaging, laboratory, etc.); 2) total OR cost (including the OR team, OR facility base, and anesthesia); 3) total intraoperative monitoring (IOM)-related costs (including electrode needle cost, base test cost, and IOM by a technician); 4) costs for chargeable supplies used in the OR; 5) pharmacy costs; 6) imaging costs; 7) laboratory costs; and 8) costs for physical therapist evaluations and services, as well as those for occupational therapist evaluations and services. This study specifically reports the hospital-related costs of care during the inpatient phase of care and within 30 days of surgery of the study population treated in 2012. The physicians’ professional fees were not included in this activity-based cost analysis.

For each cost activity, the percentage of the total cost of hospitalization and the percent coefficient of variation were calculated. The coefficient of variation, or relative variability, is key in health-finance and decision-support departments. It is defined as the ratio of the standard deviation to the mean and assesses the dispersion of cost data for each cost activity. If the cost incurred by an activity that is performed for all patients is relatively constant, then the coefficient of variation is low. An example is the pretreatment unit cost; all patients who have elective surgery incur this cost, and there is almost no variation in the cost for this activity. If the cost is incurred by an activity that is performed on some patients (but not all) or if the cost of that activity varies, then the coefficient of variation is higher. An example is postoperative imaging; after we revised the standard order for postoperative imaging, not all patients incurred this cost.

Results

Demographics of the Study Population

In total, 27 consecutively treated patients (15 male and 12 female) were included in this study, and their mean age was 51.2 years (range 15–77 years). Overall, 14 patients underwent surgery for the resection of a nonfunctional adenoma.

Time Cycles Throughout the Index Hospitalization and Associated Cost Data

Table 1 presents the average time cycles related to the OR and various bed assignments throughout the index hospitalization and associated cost data. Two patients boarded in the post-anesthesia care unit, one for 11.3 hours and the other for 23.3 hours, as a result of absent floor bed availability. Intensive care unit bed assignment was not routine in the postoperative period. Of the 27 patients, 4 required a postoperative stay in the ICU. The indications for these ICU stays included severe obstructive apnea, new perioperative hemodynamic instability, significant preoperative comorbidities, and intraoperative internal carotid artery injury. With all postoperative bed assignments considered, the average total postoperative LOS was 2.70 days (me-

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TABLE 1: Time cycles related to the OR and bed assignments and associated costs*

Activity	Average Time	Average Activity Cost (\$)
OR		6110
total OR	267 mins	
preparation	42 mins	
surgical	207 mins	
PACU	275 mins	899
ICU	30 hrs	2503
Floor (monitored & standard)	47.5 hrs	4729

* PACU = post-anesthesia care unit.

dian 2 days). Figure 1 shows the distribution of LOS and the percentage of patients discharged on Postoperative Day (POD) 2 and POD 3 by noon.

Intraoperative Services, Chargeable Supplies, and Associated Costs

As of 2012, we coordinate intraoperative electroencephalogram–somatosensory evoked potential (EEG–SSEP) monitoring in selected cases, as determined by the following criteria: 1) age > 75 years; 2) Cushing's disease and age > 60 years; 3) history of myocardial infarction or stroke; 4) planned exploration of the cavernous sinus; and 5) previous stereotactic radiosurgery. In these cases, IOM was used as an adjunct to intraoperative navigation and intracranial Doppler ultrasonography.^{5,6,20,21} In the present study population, 12 of 27 patients had intraoperative

Fig. 1. Upper: Length of postoperative stay (in days). **Lower:** Percentage of patients discharged (D/C) by POD 2 and POD 3 before noon.

EEG–SSEP monitoring. For these 12 patients, the average total cost for IOM was \$1882, and the average cost of the electrode needles was \$677. No carotid artery injuries occurred during the study period. This practice was revised, and the use of IOM during pituitary adenoma surgery is now the exception at our institution.

After the cost-containment initiative, in which the need for sending an intraoperative frozen section for analysis for all patients was revised, frozen-section analysis was performed for only 9 of the 27 patients. For these 9 patients, the average total cost for frozen-section analysis was \$426 per patient. All patients, however, benefited from histopathological assessment, with an average cost of \$837 per patient. Regarding the chargeable intraoperative supplies, dural sealant was not used in any patients in 2012. Dural patches had been introduced to our reconstruction armamentarium and were used in 9 of the 27 patients, with an average cost of \$641 for patients in whom a patch was used. The average total cost of all chargeable OR supplies was \$291 per patient for this study population.

Postoperative Ancillary Services and Associated Costs

Because the standard order for postoperative brain MRI was revised in 2012, only 14 of the 27 patients underwent postoperative brain MRI at least once. Including head CT (n = 2) and other imaging modalities performed in the postoperative phase of care (n = 4), the average cost for postoperative imaging was \$1630. The average total laboratory cost was \$1242. The average total pharmacy cost was \$784. Table 2 summarizes the average costs per activity.

Contribution to the Total Cost of Hospitalization and Coefficient of Variation

Overall, the 2 most expensive cost activities during the index hospitalization were the total OR and total bed-assignment costs. Together, these 2 activities represented more than 60% of the cost of the index hospitalization.

TABLE 2: Summary of average activity costs among the patients using the resource*

Activity (or resource)	No. of Patients Using the Resource (n = 27)	Average Cost (\$)
IOM		
monitoring	12	1882
needles	12	677
pathology		
frozen-section analysis	9	426
histopathological assessment	27	837
OR charged supplies		
dural patch	9	641
total of charged supplies	27	291
postop inpatient imaging	14	1630
all laboratory	27	1242
all pharmacy	27	784

* Other than OR and bed-assignment costs.

Postoperative imaging and laboratory costs came head to head for third place. Although the value-improvement initiatives contributed to a reduction in the variation in overall cost of the index hospitalization (Fig. 2), specific cost activities remained relatively variable within the patient population, namely the following: 1) OR charged supplies; 2) postoperative imaging; and 3) intraoperative neuromonitoring. However, each of these cost activities contributed to less than 10% of the cost of the index hospitalization. For each cost activity, Fig. 3 plots the percentage of the cost of hospitalization and the percent coefficient of variation.

Disutility of Care Throughout the Surgical Episode of Care

Table 3 summarizes disutility of care or treatment throughout the surgical episodes of care, as classified in the Outcome Hierarchy methodology by Porter.^{18,19} None of the patients returned to the OR. There were no carotid artery injuries or postoperative CSF leaks in the study population. Three patients were readmitted within 30 days of the surgery—2 for symptomatic hyponatremia and 1 for clinically manifested adrenal insufficiency—and the average LOS was 2.33 days. In this series, none of the patients underwent a reoperation during a readmission. Cost related to readmission within 30 days and reoperation within 30 days represented less than 5% of the total cost of the surgical episode of care for patients undergoing an endoscopic endonasal procedure for the resection of a pituitary adenoma.

Discussion

Involving Physicians in Cost-Assessment and Cost-Containment Initiatives

Worldwide, concerns have been expressed regarding the sustainability of US health care, where spending is increasing yearly by 4%–6%.^{11,12} The responsibility to reduce the cost of health care is shared by multiple entities, including trial lawyers, health insurance companies, employers, pharmaceutical and device manufacturers, hospitals and health systems, practicing physicians, and patients.^{11,12,22}

Physicians' perception of their responsibility to reduce cost is nuanced, in part because of the inherent tensions in their professional roles of serving patients individually and society as a whole.²² Although physicians have attributed a higher degree of responsibility for controlling cost to external entities, the new payment paradigm set forth by the ACA of 2010 (Pub. L. 111–148) will require physician involvement in health economics. Physicians who understand what activities drive the cost of their care delivery (high-cost activities, variables, non-value-adding activities, etc.) will be able to strategically redesign their care pathways with the objective of maintaining great quality and minimizing cost.^{2,3}

Cost-Containment and Cost-Reduction Strategies: Identifying High-Yield Opportunities

In this cost analysis, we aimed to achieve the following: 1) increase awareness of various costs incurred throughout the episode of care for patients undergoing an endoscopic endonasal procedure for the resection of a pituitary adenoma; 2) understand the relative contribution of each cost activity to the total cost of care; and 3) help guide the selection of targets for cost-containment strategies. Cost activities that involve all patients in a care pathway, contribute the most to the total cost of hospitalization, and contribute the greatest variation should be prioritized. In this study population, although the activity “total OR cost” had the highest percentage of total cost of hospitalization, it had the lowest variation. Although our first effort to streamline the intraoperative surgical process was coordinated in late 2011, revisiting opportunities to further safely reduce total time in the OR is warranted. Examples of potential opportunities include the following: 1) standardizing in-parallel patient preparation before incision; 2) preventing “waiting time” between the change of surgical teams (otolaryngology and neurosurgery); 3) preventing waiting time to get a missing supply; and 4) optimizing the coordination of OR flow and preventing “on-hold” events.¹⁵ In addition, total OR costs may vary among providers depending on the surgical technique used (microscopic vs endoscopic) and even within the endoscopic approach (maximal standard expo-

FIG. 2. Distribution of index hospitalization costs after the implementation of process-improvement and cost-containment initiatives.

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FIG. 3. Cost-containment prioritization matrix. The x axis presents the percent coefficient of variation, and the y axis presents the percentage of the cost of the index hospitalization. The activity that contributes the most to the index cost of hospitalization with the greatest variation is the ideal target. The cost activities refer to the following data points: 1 = pretreatment unit; 2 = OR; 3 = laboratories; 4 = pathology; 5 = post-anesthesia care unit; 6 = bed assignment; 7 = IOM; 8 = OR charged supplies; and 9 = postoperative imaging.

sure vs tailored exposure to the lesion, universal harvesting of a pedicled flap vs universal rescue flap preparation vs no flap), individual improvement in technical skills in one or many techniques over time, and increased experience of teamwork for surgical teams working in collaboration.^{15,17}

TABLE 3: Disutility of care or treatment*

Disutility	No. of Patients (%)	
	Study Population	Comparison Population
need for blood transfusion	0 (0)	0 (0)
carotid artery injury	0 (0)	1 (4.7)
new postop hemianopsia	1 (3.7)	0 (0)
new postop EOM deficit, transient	2 (7.4)	0 (0)
infection	0 (0)	0 (0)
CSF leak	0 (0)	2 (9.5)
hyponatremia	15 (56)	6 (29)
diabetes insipidus	11 (41)	5 (24)
reop during index hospitalization	0 (0)	2 (9.5)
readmission	3 (11)†	1 (4.7)‡
reop during readmission	0 (0)	0 (0)

* Disutility of care or treatment data are presented for the study population (n = 27) composed of patients treated after the implementation and maturation of quality-improvement initiatives and the implementation of cost-containment initiatives in the Pituitary Tumor Program. For comparison, disutility of care or treatment data are provided for a similar cohort of patients undergoing an endoscopic endonasal procedure for the resection of a pituitary adenoma by the same surgical team before the implementation of value initiatives in 2012 in the Pituitary Tumor Program (comparison population n = 21). EOM = extraocular muscle.

† Two patients with symptomatic hyponatremia and one with symptomatic adrenal insufficiency.

‡ Symptomatic hyponatremia.

The activity “total bed-assignment cost” had the second highest percentage of total cost of hospitalization and had a relative greater variation (Fig. 3). The higher percent coefficient of variation means that the costs related to this activity are more dispersed. Plotting both of these variables (percentage of total cost of hospitalization and coefficient of variation) enables physicians to identify high-yield cost activities.

Ongoing Process-Improvement and Cost-Containment Initiatives

New process-improvement and cost-containment initiatives have been undertaken to further increase the value of delivered care in the pituitary care pathway. The pituitary postoperative protocol is now reviewed with each new resident team to ensure that the clinical indications for sending a patient to the ICU postoperatively and the indications for ordering postoperative MRI are clearly understood.

At our institution, the introduction of IOM in selected cases occurred at a time when many large centers were using this modality routinely for all endonasal endoscopic procedures, although it is not necessarily supported by robust scientific evidence.^{20,21} We recognize that the same outcome may have been observed without the use of IOM in these potentially higher-risk patients, and other factors, such as increased surgical team experience, also may have contributed.^{20,21} Given the lack of clear clinical benefit and, more recently, the observation of the costs incurred by this activity, our group has elected to discontinue the use of IOM for pituitary adenoma surgery according to our previously established criteria; IOM is now the exception.

A workforce is optimizing the coordination of multidisciplinary care, including that from head and neck and endocrinology care clinicians, on the day before and the day of discharge with the aim of achieving a reliable and predictable LOS, because LOS is a major driver of cost. Another workforce is working on optimizing the follow-up after discharge, specifically in regard to the identification of patients with precursor signs of hyponatremia, because this condition was the main driver of readmissions.

Current Limitations and Potential Solutions

We recognize that this study is retrospective in nature. Although the population sample was relatively small, we have reported a contemporary cost analysis and included all consecutive patients treated by one surgical team during the study period. As is the case for the majority of cost analyses in health care, descriptive statistics were used to summarize the cost findings.

Variable Costing Methodologies. Most health systems and hospitals have an established costing system in place. One methodology is used to determine the costs of hospital-related activities (e.g., the Activity-Based Costing [ABC] model), and another is used to determine the costs of physician-related activities (i.e., Resource-Based Relative Value Scale [RBRVS] system). Regarding the determination of the costs of hospital-related activities, there is currently no consensus on the most accurate methodol-

ogy. A comparison between institutions is not meaningful, because the costing structure may vary and, as a result, so may the unit cost per activity. Therefore, we recognize that the costs reported in this study may vary significantly from those in other institutions across the nation. Multiple factors, in addition to the hospitals' cost structure (e.g., human resources, available technology, real estate, and related mortgage), preclude any comparison. The Centers for Medicare and Medicaid Services will need to take such factors into consideration as it establishes national benchmarks for the cost composite of the physician value-based payment modifier.

Aiming Toward the Cost of an Episode of Care. The current cost analysis presents the hospital-related costs to deliver care during the index hospitalization and any postoperative readmission or reoperation within our institution. Some patients may come to our institution for only part of an episode of care, with other phases of their care (e.g., preoperative imaging, pre- and postoperative blood work, and urgent care visit if needed) being delivered at other facilities. Tabulating the cost incurred throughout the episode of care is challenging when the costs can be incurred by many centers that are not all part of the same health system (clinics, imaging centers, university hospital, etc.). The development of accountable care organizations will help address this barrier by consolidating the care delivered to a patient population within one health system using a single constant costing method.

Time-Driven Activity-Based Costing Model. The time-driven activity-based costing method, described by Kaplan et al.,^{9,10} is an improved version of activity-based costing and is being piloted in various specialties and institutions throughout the nation. It integrates the cost of each resource used in the process and the quantity of time each patient spends with each resource.^{9,10} It is important to note that hospital-related and physician-related costs are calculated using the same methodology—enabling us to appropriately add apples with apples. We are currently piloting the time-driven activity-based costing method in a neurosurgical service line to assess how this method may orient toward different strategies to drive cost containment and reduction and, ultimately, optimal value.^{9,10} This model has the potential to capture all costs (hospital and physician related) incurred throughout the episode of care; it is being piloted by some specialties to prepare bundle-pricing estimates.

Need for Real-Time Cost Data. Whatever the model used to calculate them, increasing costs are not always a palpable phenomenon. Although an initial cost assessment requires a population-based analysis, such analysis provides cost data for care delivered during a specific time frame only. A review of real-time cost data per service line will be a prerequisite for monitoring activity costs and total costs of the ongoing surgical episode of care.¹⁴ In rare instances, an activity may have been charted but not coded, or vice versa. Such discrepancies can be easily captured with real-time correlation between activities performed and their related costs incurred (filling the cost buckets as they are incurred). Review of real-time cost

data will also raise awareness among physicians of the cost their care is incurring, as the care is delivered, instead of from a retrospective assessment.

The Impact of Cost-Containment Strategies

The prospective maintenance of a cost-containment strategy and active monitoring of costs should not alter physicians' decision-making processes for investigations or procedures that add value to the care they deliver to patients. However, physicians do have a responsibility to refrain from exposing their patients to non-value-adding tests or procedures. The "Choosing Wisely" campaign, initiated by the American Board of Internal Medicine, initiates conversations between physicians and patients to ensure that the appropriate care is delivered given each patient's individual situation. The American Association of Neurological Surgeons is one of more than 60 specialty societies participating in this campaign.

It should be clear to providers engaging in cost-containment initiatives that decreasing costs is not the ultimate goal. A cost-containment strategy increases the value of delivered care only when clinical outcomes improve while the costs simultaneously decrease. Note that clinical outcomes may not always be sensitive enough to demonstrate improvements in care delivery. Assessing the impact of cost-containment initiatives from a patient's perspective using various patient-reported outcome questionnaires may document subtle effects and strengthen their value-adding impact.

Conclusions

Physicians will need to tackle the cost component of the value equation, not only because of the emergence of new methods of reimbursement but also because this is the only way they will be able to truly deliver optimal value of care to their patients. Establishing collaborations with finance and operation teams is critical for completing a detailed analysis of costs incurred in providing care in a service line. The proposed prioritization matrix tool will help guide the selection of targets for cost-containment and cost-reduction efforts.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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