Abstract:

Objective: There is a paucity of evidence describing the price information that is publicly available to patients for neurosurgical procedures. We sought to investigate the public availability and usefulness of price estimates for non-emergent, elective neurosurgical interventions.

Methods: Google was used to search for price information related to 15 procedures in 8 major US healthcare markets. We recorded price information that was published for each procedure and took note of whether itemized prices, potential discounts, and cross-provider price comparisons were available.

Results: Online searches yielded 2356 websites, of which 228 (9.7%) offered geographically-relevant price information for neurosurgical procedures. Although accounting for only 16.4% of total search results, price transparency websites provided most treatment price estimates (74.1% of all estimates), followed by clinical sites (19.3%), and other related sites (5.3%). The number of websites providing price information varied significantly by city and procedure. Websites rarely divulged data sources, specified how prices were estimated, indicated how frequently price estimates were updated, offered itemized breakdowns of prices, or indicated whether price estimates encompassed the full spectrum of possible healthcare charges.

Conclusions: Under 10% of websites queried yield geographically-relevant price information for non-emergent neurosurgical imaging and operative procedures. Even when this information is publicly available, its usefulness to patients may be limited by various factors, including obscure data sources and methods, as well as sparse information on discounts and bundled price estimates. Inconsistent availability and clarity of price information likely impede patients' ability to discern expected costs of treatment and engage in cost-conscious, value-based neurosurgical decision-making.

Introduction:

As overall healthcare costs rise, so too have health insurance and out-of-pocket expenses for patients. Even among the insured, combined employee premium contributions and deductible costs as a share of median income have nearly doubled over the past decade.[7] In the setting of climbing cost-sharing requirements in the United States, patients must increasingly weigh treatment prices against expectations of their clinical benefits.

While it may be needed to underpin cost-conscious clinical decision-making, peer-reviewed literature examining the quantity and quality of publicly-available treatment price information to patients is sparse.[11,14] This is of particular importance in surgical specialties,[2,8,13,16,17] where interventions incur comparatively high costs.[9]

Policymakers have nevertheless started to enact unfunded price transparency initiatives with the aim of promoting value-based healthcare.[5,6] For instance, as of 2021, hospitals are now required to post their standard pricing information online. By 2023, health plans will also be required to offer online shopping tools for patients to generate personalized estimates of out-of-pocket costs for 500 of the "most shoppable items and services."[5] Yet, the degree of compliance with recent price transparency mandates remains unclear, as does the usefulness to patients of any publicly-available price information that may exist. For example, what constitutes "shoppable" or "standard" services remains unclear, particularly with respect to surgical specialties. From a patient's perspective, difficulty in parsing through machine-readable hospital price files may cause them to turn to other public data sources. Additional information on the quantity and quality of publicly-available treatment price information is needed to help guide ongoing price transparency reforms.

Surgical cost and policy developments have prompted recent studies to examine the availability of consumer prices for neurosurgical procedures.[4,12] These efforts nevertheless may only consider single procedures; may be limited to a handful of providers; may not account for non-hospital surgical centers offering elective, outpatient interventions; and may not attempt to characterize potential gaps in any treatment price information that is made available to patients.

In this paper, we systematically examine what price information is available to US patients with web searches for non-emergent neurosurgical procedures. Our goal is to get a snapshot of how readily patients can obtain price information with which to inform their choices regarding neurosurgical care and—by evaluating the information that is published—assess its potential usefulness to patients.

Material and Methods:

Patients undergoing non-emergent, elective neurosurgical procedures are likely to use targeted web searches to find price information for treatments offered by competing providers. Given its hold of 85% of the global market share of search engines, Google was selected as our search engine of choice to find treatment prices associated with the following 15 neurosurgical imaging and operative procedures: MRI (brain), CT (brain), MRI (spine), CT (spine), lumbar puncture, deep brain stimulation, implantation of spinal cord stimulator, anterior cervical discectomy and fusion (ACDF) (spine), cervical fusion (spine), lumbar fusion (spine), vertebroplasty (spine), kyphoplasty (spine), laminectomy (spine), laminotomy (spine), and foraminotomy (spine). These interventions were identified by a panel of spine surgeons and neurosurgeons as common procedures involving the brain and spine that may routinely be performed on a non-emergent, elective basis. Imaging procedures such at CT and MRI were included due to their importance in the planning process for most neurosurgical interventions and to provide a comparison between more ubiquitous or generic procedures and highly specialized neurosurgical procedures. All web searches were performed on "incognito mode" to help mitigate the confounding effect of search history and cookies.

A spectrum of geographical areas were chosen to achieve a representative sample including the two most populated cities from each of the two most populated states in the United States, and one city from the next five most populated states if they also hosted any of the twenty highest-performing neurology & neurosurgery programs in the United States, per *US News & World Report*.[18]. Based on these criteria, searches were performed for the following 8 cities: New York City, NY; Los Angeles, CA; Chicago, IL; Houston, TX; Philadelphia, PA; Cleveland, OH; San Diego, CA; and San Antonio, TX.

Building on similar studies in internal medicine,[11] the following phrase was used for all web-based search queries: "cost of [insert intervention name] in [insert city name]." All non-advertisement websites in the first 2 pages of search results were reviewed and included in our analysis. To mimic the behavior of non-medically trained consumers, the websites in the first two pages of search results were not pre-screened or sorted by relevance prior to being included. To characterize data sources, these websites were categorized as peer-reviewed publications or

as focusing on price transparency, clinical, generic relevant, other, or unrelated information.[11] See **Table 1** for information on how these categories were defined.

A data sheet was created that took note of the following features for each website: procedure, city, the website's name, as well as all price information that was published for each procedure in question. In order to assess the potential usefulness of this information to patients, we also recorded any itemization of treatment prices, how price information was presented (e.g. means, medians, measures of spread), information on potential discounts to patients, and cross-provider price comparisons. To further assess data accessibility, we also recorded the number of sequential links that searchers needed to click in order to access relevant price information ("snowballed" data). Chi-square tests were used to compare the number of websites with region-specific price estimates across procedures and locations. This study did not require ethical approval, as it was exclusively based on information available in the public domain.

Results:

Our search queries yielded a total of 2356 websites across the 8 cities and 15 procedures that were included in our final analysis (about 20 websites/city/procedure). The largest share consisted of clinical sites (722, 30.6%), followed by peer reviewed publications (N= 544, 23.1%), and price transparency websites (N= 386 , 16.4%), while 126 sites provided generic relevant information (5.3%), 378 provided other relevant information (16.0%), and 200 were unrelated to the search query (8.5%).

Price Estimate Availability

Although they accounted for only 16.4% of total search results, price transparency websites provided most publicly-available treatment price estimates (74.1% of all price estimates). They were followed by clinical sites (19.3%), and other related sites (5.3%). Among all websites, only 228 (9.7%) yielded price information that was specific to the cities included in our analysis.

Availability of Price Information by Geography and Procedure

The number of websites providing price information varied significantly by city (χ=40.6, P<0.001), ranging from 16 (5.4%) in San Diego to 47 (16.2%) in Cleveland (**Figure 1**). Cleveland had the largest share of clinical sites (5.2% of total for Cleveland) and Philadelphia had the largest share of price transparency sites (13.5% of total for Philadelphia), with price information that was specific to those geographies (**Figure 1)**.

The number of websites providing price information also varied significantly by procedure (χ=208.8, P<0.001), varying from 0/161 (0%) for deep brain stimulation to 44/329 (13.4%) for MRI (brain, spine) (**Figure 2**). In general, price estimates were more readily available for less complex and more ubiquitous neurosurgical procedures, such as CT and MR imaging of the brain or spine. No geographical area had price availability for all queried procedures.

Usefulness of Available Price Information

Price transparency websites were most likely to disclose relevant price information for the procedures and cities that were considered in this analysis, with 43.8% (169/386) of price transparency websites presenting geographically-relevant information. Clinical sites were a

distant second, with 6.1% (44/722) containing geographically-relevant price information. Some did so while giving patients guidance on what might be considered a "fair" price for interventions, given the range of prices across local providers. However, even price transparency websites provided information for only a limited number of interventions. Even when they did, these websites often did not divulge data sources, specify how prices were estimated, indicate how frequently price estimates were updated, provide an itemized breakdown of prices, incorporate tools to calculate out-of-pocket costs to patients after accounting for health insurance, or indicate whether price estimates encompassed the full spectrum of possible healthcare charges. The lack of disclosure of pricing algorithms calls into question the accuracy of price information, as it is not possible for the consumer to verify data sources and estimation methods. To examine the accuracy of publicly listed price information, subsequent research efforts may wish to compare listed vs realized prices for neurosurgical procedures.

For instance, Healthcarebluebook.com was the only source that itemized fees included in final bundled treatment price estimates (e.g. physician fees, technical and imaging fees, facility services, anesthesia), but it provided limited further granularity in its price data. The website identified a "fair" price ($12932) for laminectomy in New York City, New York among all providers, an undiscounted price range ($4667-$89000), and a breakdown of this fair price into facility, physician, and anesthesia components. Yet, it did not specify whether additional fees could apply, describe how price data were sourced or generated, or identify the factors that could account for highly variable treatment prices and influence the final cost to individual patients.

Clinical websites almost exclusively gave bundled price estimates, with two exceptions being Houston-based clinical sites that delineated between included goods and services, such as surgeon rate, hardware, anesthesia, and hospital charges. Moreover, few websites provided information on available discounts; radiologyassist.com was the only site available in New York, Philadelphia, Houston, and San Antonio to do so for MRI services for the uninsured.

Discussion:

Several dichotomies in healthcare price reporting exist, including unbundled versus bundled (i.e. inclusive of facility services, anesthesiologists, etc.), discounted versus undiscounted, and prices based on costs incurred by providers versus costs paid by insurers. Such dichotomies in price reporting likely make the task of finding data on actual cost to patients an onerous one and its utilization challenging.

Improved price transparency may help patients make healthcare decisions that are better aligned with their own preferences for treatment, particularly as total healthcare spending rises. Greater certainty over treatment costs could help spur competition and lower healthcare prices, at least for some services,[19,20] yet may also lead to an increase in service utilization and help providers optimize their use of resources as payment models evolve.[3,10]

These may be some of the motivations behind recent healthcare price transparency initiatives, including the 2021 US Hospital Price Transparency Rule that aims to make "it easier for consumers to compare prices across hospitals and estimate the cost of care."[6] Yet, relatively little peer-reviewed literature has attempted to examine the quantity and quality of publicly-available treatment price information—particularly within surgical specialties—even though it may be needed to guide further policy action.

We find that treatment price information is only infrequently and inconsistently made publicly available in neurosurgery, with fewer than 10% of websites identified through targeted searches yielding geographically-relevant price estimates for non-emergent, elective neurosurgical procedures.

Infrequent and inconsistent disclosure of treatment prices may in part reflect local differences in regulatory control. Among the cities included in our analysis, Cleveland had the largest share of websites with publicly-available treatment price estimates. Even in this region, websites did not encompass all possible neurosurgical interventions and did not always offer price estimates for the same set of interventions. These findings may in part reflect Ohio state law, which requires that hospitals publish price information lists free of charge on their website containing the "usual

and customary charges" for room and board, as well as those associated with the thirty most common laboratory and x-ray and radiological procedures, emergency and operating room services, and physical, occupational, and pulmonary therapy services.[1] Thus, even in the cities with relatively greater degrees of healthcare price transparency, published information more commonly represents more common or generic procedures, rather than more specialized neurosurgical procedures.

Even in this regulated environment, however, full disclosure of prices for surgical interventions is unlikely to occur. First, providers are not explicitly required by Ohio law to publish bundled prices; indeed, published charges may or may not include fees that may be associated with neurosurgical care, including hospital-based anesthesiologists, radiologists, pathologists, and emergency room physicians. State law also requires hospitals to make price information lists publicly available for review, but does not appear to require the same of ambulatory care facilities, though they too may offer surgical treatment. Furthermore, legislative requirements may not apply to complex surgical procedures, where "usual and customary charges" may be variable or difficult to define. These issues give some perspective on the challenges and opportunities that could arise from ongoing healthcare price transparency reforms.

Uncertainty in how to measure, and price for, risk in neurosurgery may also head off treatment price disclosure. While we find that price estimates are, on the whole, only rarely published, they are more frequently available for neurosurgical procedures that are less technically complex and more commonly performed (**Figure 2**). For example, prices for CTs and MRIs of the brain and spine were more often available than for the more invasive operative procedures considered in this study. This is consistent with a recent report showing greater price transparency for medical studies (upper gastrointestinal endoscopies, brain MRI, cholesterol panel) than for hip replacement.[11] Among operative procedures, prices were also most frequently disclosed for lumbar fusions, which are relatively common in the United States.[15] Factors such as reduced inter-provider competition, increased profit potential, and proportion of non-publicly insured patients may certainly influence the availability of price information. Yet, these findings also suggest that neurosurgical providers may be more likely to publish treatment prices when there is greater certainty over patient clinical course and the costs that will be incurred from care. Further

research is needed to investigate how clinical and economic uncertainty, as well as other factors, affect the disclosure of surgical treatment prices.

The results of this study must be considered within the context of its limitations. All of our web searches were performed using Google's "incognito mode" in order to avoid the confounding effect of patient search history and cookies. In practice, however, patient web searches may not be conducted using "incognito mode" and may therefore be influenced by these factors. Moreover, an inability to avoid the geographic influence of computer IP addresses even when using incognito mode may mean that any price research will be influenced by browsing history, an individual's location, and cookies. Future research may avoid confounding from computer IP address locations by utilizing a variety of different virtual private networks in the course of Google searches to examine its effect on price availability by location. Additionally, our analysis was limited to websites that appeared within the first two pages of search results. The presence of websites with potentially useful price information on subsequent pages would, however, reinforce the notion that significant challenges exist in the accessibility of online price information. Furthermore, without information on patients' health insurance plans, this study could not disaggregate published treatment prices into out-of-pocket expenses and the charges that would be covered by health insurers. Publicly-available price information is nevertheless likely to closely reflect out-of-pocket costs to uninsured patients, while also providing those with insurance a baseline from which to estimate co-payment, co-insurance, and deductible costs using the terms of their health insurance policy. Future studies may wish to examine the accuracy of publicly-available treatment price estimates by evaluating their relationship with actual costs incurred by patients.

It remains the case that treatment prices for elective neurosurgical procedures are rarely publicly available. When treatment price information exists, obscure underlying data sources and methodologies raise questions over the reliability of available price estimates and make it difficult for patients to compare neurosurgical treatment prices across providers. In the absence of any guarantee that published treatment prices are all-inclusive, infrequent and inconsistent disclosure of detailed treatment price information likely further limits patients' ability to discern

the true cost of their care and therefore factor costs as a component of responsible consumer decision-making.

Conclusions:

Actionable price information can help empower consumers to self-advocate for control of medical costs and reclaim autonomy in their own care. Identifying useful price information for elective procedures in the high-cost, complex surgical field of neurosurgery nevertheless remains challenging. We find that treatment price information is infrequently and inconsistently made publicly available in neurosurgery, rarely includes holistic information on the bundling of prices, and is disproportionately easier to find for less complex, more ubiquitous neurosurgical procedures. As may be highlighted by recent federal price transparency initiatives, efforts to overcome these challenges and improve price transparency are needed steps if we are to move towards a cost-conscious, value-based approach to neurosurgical decision-making.

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Figure and Table Legends:

Table 1. Website Classification Definitions

Classification	Definition	Examples
Price transparency	Principally provides information about price of procedure, treatment, imaging in question	Healthcarebluebook.com Clearhealthcosts.com
Clinical site	Clinic, private practice, hospital, radiology clinic, or health system website offering the imaging/procedure service (e.g. hospital website, independent ambulatory clinic website, independent radiology clinic websites)	Tristateimaging.com Mainlinehealth.org
Generic relevant information	General information relating to the procedure (e.g. description of procedure, website listing physicians who perform procedure)	Healthline.com Webmd.com
Peer reviewed publication	Peer reviewed journal or magazine article relating to the procedure	Journals.lww.com Ncbi.nlm.nih.gov
Other	Any other website related to the search query (e.g. blog post discussing personal experience with procedure, news article profiling physician performing procedure)	Consumer.healthday.com Isass.org Tdi.texas.gov
Unrelated site	Website that has no relevance to the search query (e.g. veterinary medicine websites)	Time.com Glassdoor.com

Notes:

Website classifications adapted from Kratka et al. 2018.(3)

Figure 1. Availability of price information by city and website type, % of websites searched; Notes**:** Percentages correspond to number of websites providing price information, of total number of websites searched for that city.

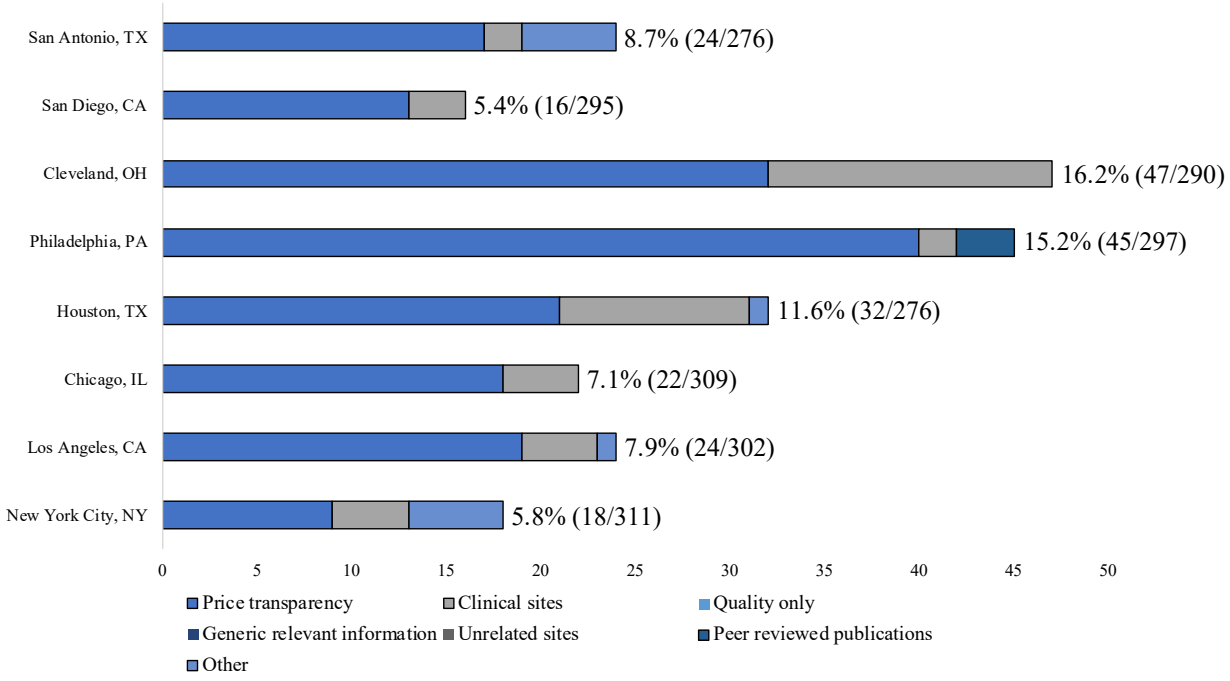

Figure 2. Availability of price information by intervention, % of websites searched; Notes**:** Percentages correspond to number of websites providing price information for the intervention, of total number of websites searched across all cities.