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12-12-2018

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Predicting Overcharge in Common Healthcare Procedure with High Payment Variation

Research-in-Progress

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Abstract

Medicare payment to care providers for the same service varies widely despite cost-of-living adjustments. In turn, providers bill more than the allowable limit, i.e., they overcharge. In this research, our focus is to identify the key predictors of such overcharge. Using the 2014 Physician Payment and Utilization data, we explore one of the most common procedures (non-complex cataract surgery) with the highest degree of payment variation, we model this as classification problem based on feature sets comprised of provider, procedure, and practice characteristics. We find that overcharge behavior is a practice level phenomenon with bigger providers serving larger patient base overcharging more and receiving higher payment. Provider gender, credentials, and affiliation, patient demographics, on the other hand, do not drive overcharge. Our work highlights the policy imperative of higher transparency in Medicare's price-setting rules and the need for developing guidelines to reward high-value providers.

Keywords

Binomial Classification; Prediction; Healthcare cost

Introduction

It is a common knowledge that health care providers usually charge Medicare (the federal health insurance program in the United States for the disabled and elderly) a higher amount than the allowable limit set by the Centers for Medicare and Medicaid Services (CMS). Healthcare policy researchers have argued that high excess charges leads to financial duress on the uninsured and out-of-network patients (Bai and Anderson 2017). Absent any voluntary discount from the provider, these patients are often charged the full-price. On the other hand, physician and provider groups have argued that Medicare payment reimbursement is often not sufficient to cover the cost of service. Indeed, Medicare reimbursement for the same procedure varies widely, beyond geographic cost-of-living adjustments. Consequently, there exists an observable juxtaposition with Medicare and private insurance spending (Gawande 2009).

Understanding the source and cause of provider overcharge is a crucial policy imperative. The question we seek to answer in this article is: can we identify the key predictors of provider overcharge based on features extracted from procedure, practice, provider, and patient demographic information sources? The procedure dimension provides information regarding service volume, the number of unique beneficiaries served, and place of service. The practice dimension offers information about the entire practice of a provider, such as count and volume of different services performed, beneficiary demographics such as risk score, race, and gender distribution, dual-eligibility, as well as geographic location. Finally, the provider dimension captures attributes such as gender, credential, and specialty. Based on Medicare claims and reimbursement data from 2014, we focus on the procedure for non-complex cataract surgery, identified by the Healthcare Common Procedure Coding Systems (HCPCS) 66984. We chose procedure code 66984 as it is one of the four procedures exhibiting abnormal payment variation among the top forty procedures accounting for almost half of all Medicare expense in 2014. Among the four procedures, 66984 had the highest service volume and total payment by Medicare, $1.68 billion for 6,887,517 services.

To gain insights into the key influential predictors for high provider overcharge ratio, we model the problem as a binominal classification problem. The classification problem is structured as classifying

providers with excess overcharge behavior versus the one that do not. Using machine learning algorithms, we analyze the classification performance to find the best predictive model. Our results illustrate that there is a strong correlation between practice and provider level overcharge, and provider propensity to overcharge increases with the volume of patients they serve. Even though Medicare reimbursement is lower for the providers who overcharge, a bulk of Medicare money is still going to these providers who bill much higher compared to their peers.

Research Approach

Data

Data from 2014 Provider Utilization and Payment Data: Physician and Other Supplier for Medicare Part B fee-for-service (FFS) beneficiaries is used in this study. In 2014, total Medicare payment for Part B FFS amounted to $78.22 billion covering 5973 unique procedure codes. Of these, 37 HCPCS accounted for almost half ($40.64B) of Medicare's total spending. Within these most expensive procedures, four services show abnormally high degree of variation in terms of payment per service. Of these four, we choose HCPCS 66984: Removal of cataract with the insertion of lens since it had the highest service volume and total payment by Medicare. We combined two files. The first file contains detailed information about the procedure such as service volume, # of unique beneficiaries, average payment and charge amounts for each procedure code (identified by HCPCS) serviced by a provider. A second file contains providers' aggregate payment and charge amounts (summed over all procedure codes), along with practice-level information such as geographic location, beneficiary risk score, racial and gender breakdown. These two files are combined using the provider's National Provider Identification (NPI) as the index. A separate file from CMS with Urban/Rural/Very Rural indicators by 5-digit zip code was combined with this data set.

Method

To gain insights into the key influential predictors for high procedure overcharge ratio, we model the problem as a binominal classification problem. The classification target considers the fourth quartile of overcharge ratio as the positive class, i.e., class of interest, and the remaining quartiles combined as the negative class.

Using machine learning algorithms, we analyze the classification performance to find the best predictive model based on model evaluation criteria discussed below. In conducting the predictive modeling and analysis, we use the 10-fold cross-validation approach to avoid overfitting and leakage of test data into the trained models. Further, for better out-of-sample generalizability, we build a variety of machine learning models, using both linear methods like Naive Bayes (NB) classifier and nonlinear methods including k-nearest-neighbors (k-NN), Elastic Net (E-Net), Gradient Boosting (GB), and Random Forest (RF). We also use neural networks (NN) and support vector machines (SVM) with both linear and nonlinear kernels. Finally, we also employ a "wisdom of the crowds" approach by building an ensemble model that computes the average prediction values of the selected top three individual models.

For each classifier, we compute the feature impact (Altmann et al. 2010) using the *permutation importance* technique. The importance of each feature is computed as a normalized score. To get a sense of the overall feature importance across all the models, we compute a combined score for each predictor through a weighting mechanism. A predictor's combined score is recorded as the weighted sum of the predictor's scores across all the classifiers. The weight is in turn computed as a normalized model importance score based on a model's predictive performance.

Current Findings

Further, we analyze the feature impact in each of the classification models built. Four of the top five predictors emerge to be related to a provider's practice characteristics (reimbursement ratio, overcharge ratio, total payment to the practice by Medicare, and number of unique beneficiaries), only one (procedure total Medicare payment amount) is associated with the procedure itself.

The feature impact analysis provides important insights that has significant policy level implications. It is important to note that provider gender, whether they are affiliated with an organization or operating as an individual, racial/ethnic makeover of patient base did not emerge as important differentiating features. This is definitely a positive discovery. What is apparent from the top 10 features and their rank, though, is the fact that overcharge behavior is essentially a practice level phenomenon. A provider who overcharges for cataract surgery, also overcharges for all other services. Upon further analysis, we observe the correlation between practice and procedure level overcharge is positive and significant. More importantly, we also observe that providers *always* overcharge by higher degree for the procedure (up to 6 times on average) than they do overall in the practice (1-3 times). With an average price tag of $450-$745, HCPCS 66984 (non-complex cataract surgery) is one of the more expensive procedures provided by ophthalmologists and ambulatory surgical centers, the two most dominant provider types. Clearly, a higher level of overcharge has a higher financial impact, both for Medicare and uninsured or out-of-network providers. The other important observation is the relationship with practice reimbursement ratio. This relationship is negative and significant, implying that Medicare does not pay as much as the providers charge for the procedure. In spite of that, a larger share of the Medicare money is going to these providers who overcharge. This is also evident by the fact the procedure and practice level total payment are among the top 4 features. The other features (procedure and practice number of unique beneficiaries, and practice service volume, and total number of unique procedures served by the provider) are all indicators of the practice size. Their relationship with the procedure overcharge is positive too. In sum, we see that large providers (servicing many beneficiaries as well as providing many different types of services) seem to be overcharging more. Even though CMS pays then a fraction of what they charge for, these providers are still eliciting a higher average price and total payment.

Conclusion and Future Research

In this paper, we have used machine learning algorithms to identify the key predictors of overcharge. Using 2014 Medicare fee-for-service beneficiary claim and payment data for cataract surgery, the procedure with highest degree of payment variability and total Medicare expense, we illustrate that overcharging is a practice level phenomenon, and also large providers overcharge more. This has significant policy implications. For Medicare, further investigation into the top quartile of overcharging providers may result in savings opportunities. Also, comparison of the same providers with commercial insurers will reveal whether the commonly observed negative relationship between commercial and Medicare prices and utilization (Romley et al. 2015) holds true for cataract surgery as well.

Our ongoing research will focus on few issues identified in the course of this study. As indicated in our model, provider type is an important feature in predicting overcharge. Further exploration is needed to understand how the prominent providers differ in terms of their overcharge behavior. Finally, we would also like to analyze the partial dependence of each of the top predictors on the procedure overcharge. This will inform us about the influence of the predictor on the procedure overcharge while controlling for other variables.

References

Altmann, André, Laura Toloşi, Oliver Sander, and Thomas Lengauer. 2010. "Permutation Importance: A Corrected Feature Importance Measure." *Bioinformatics* 26 (10). Oxford University Press: 1340–47. doi:10.1093/bioinformatics/btq134.

Bai, Ge, and Gerard F Anderson. 2015. "Extreme Markup: The Fifty US Hospitals With The Highest Charge-To-Cost Ratios." *Health Affairs* 34 (6): 922–28. doi:10.1377/hlthaff.2014.1414.

———. 2017. "Research Letter: Variation in the Ratio of Physician Charges to Medicare Payments by Specialty and Region." *JAMA - Journal of the American Medical Association* 317 (3).

Gawande, Atul. 2009. "The Cost Conundrum." *New Yorker*, June. http://www.newyorker.com/magazine/2009/06/01/the-cost-conundrum.

Romley, John A, Sarah Axeen, Darius N Lakdawalla, Michael E Chernew, Jay Bhattacharya, and Dana P Goldman. 2015. "The Relationship between Commercial Health Care Prices and Medicare Spending and Utilization." *Health Services Research* 50 (3). Health Research & Educational Trust: 883–96. doi:10.1111/1475-6773.12262.