Novelty Journals

ISSN 2394-7314

International Journal of Novel Research in Computer Science and Software Engineering
Vol. 12, Issue 3, pp: (1-7), Month: September - December 2025, Available at: www.noveltyjournals.com

Analyzing Medicare Inpatient Hospital Trends (2021–2023): Cost, Utilization, and Reimbursement Insights Using DRG-Based Analysis

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DOI: https://doi.org/10.5281/zenodo.17077127

Published Date: 08-September-2025

Abstract: **This analysis explores three years of Medicare inpatient hospital payment trends, focusing on how hospitals are reimbursed for different types of care. By examining data across hundreds of Diagnosis-Related Groups (DRGs), a consistent pattern emerges: hospitals often receive significantly less from Medicare than what they charge—particularly for complex treatments like sepsis care, transplants, and long ICU stays. Even as patient volumes recovered following the COVID-19 peak, the gap between what's billed and what's paid has not narrowed.**

Using a clustering method (KMeans), the study groups DRGs based on financial patterns. One group, in particular, stands out—high-cost services that regularly bring in lower reimbursement. This mismatch between cost and payment raises concerns for hospitals that handle the most intensive care, especially in urban areas where operating costs are already high. The data also suggest that current Medicare payment models may not adjust well for regional differences or rising healthcare expenses. Overall, this study offers practical insights for hospitals and policymakers seeking to better align reimbursement with real-world care and cost.

Keywords: **inpatient hospital analytics, diagnosisrelated group (DRG), healthcare costs, reimbursement, paymenttocharge ratio, utilization trends, clustering, inflationadjusted revenue, policy implications.**

1. INTRODUCTION

Medicare serves as the backbone of hospital reimbursement for millions of Americans. Understanding how hospitals are reimbursed based on Diagnosis-Related Groups (DRGs) is vital to assessing healthcare system performance [1], [2]. DRGs categorize hospital cases into clinically similar groups expected to require comparable levels of healthcare resources. They were introduced to establish a prospective payment system and discourage excessive spending through fee-for-service incentives.

The dataset used in this research, obtained from the Centers for Medicare & Medicaid Services (CMS), spans three years and includes inpatient hospital data segmented by DRG. These include average submitted charges, average Medicare payments, and discharge volumes for each DRG by state and year. The longitudinal structure of this data allows us to assess temporal and regional trends in both utilization and financial patterns across the U.S.

This analysis is critical because hospitals are challenged with delivering high-quality care while managing costs and complying with public reimbursement programs. By analyzing submitted charges, payments, and DRG-specific volumes over time, we highlight areas where the current Medicare reimbursement model fails to match operational realities. Furthermore, this type of study provides essential input into how health systems can be optimized post- COVID-19, as demand rises while financial risk remains high.

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2. METHODOLOGY

We collected CMS Medicare inpatient data for 2021, 2022, and 2023 from publicly available repositories. After merging the datasets, preprocessing included: removing currency symbols, converting string data to floats, filtering nulls, and aggregating DRGs by year and region. Charges were normalized for inflation using CPI-based adjustment factors to ensure accurate inter-year comparisons.

Python libraries such as Pandas, NumPy, and Seaborn were used for data cleaning and visualization. We cal- culated metrics like average charges, payments, and dis- charge rates. Further, we introduced a derived metric: the Medicare Payment-to-Charge Ratio (PCR), which measures reimbursement adequacy. A KMeans clustering model was also applied to classify DRGs based on financial risk.

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4. RESULTS AND DISCUSSION

4.1 High-Cost DRGs

Figure 1 reveals the DRGs with the highest submitted charges. These include complex organ transplant proce- dures and prolonged critical care services such as heart- lung transplantation, liver transplantation, and ECMO (ex- tracorporeal membrane oxygenation). The charges for these services exceed $1 million on average. However, Medicare reimbursement often covers less than 25% of this amount. This disparity raises serious concerns about the financial sustainability of hospitals providing tertiary and quaternary care. These DRGs represent the top tier of acute inpatient needs, often occurring at teaching hospitals or specialty centers. Including them in the analysis reveals systemic vulnerabilities and the need to reassess DRG weights for ultra-high-cost care.

4.2 Total Discharges by Year

Figure 2 illustrates the total inpatient discharges per year from 2021 to 2023. The chart indicates a progressive rebound in inpatient utilization post-pandemic. This recovery reflects resumed elective procedures and increasing admissions re- lated to chronic disease management. Total discharge trends are important to analyze as they reflect macro-level health- care utilization patterns and help anticipate demand for clinical resources. Understanding discharge patterns over time also aids health economists and policy planners in allocating budgets and addressing workforce shortages.

4.3 Most Utilized DRGs

Figure 3 presents the ten most frequently reported DRGs during the study period. Conditions like septicemia, pneu- monia, and chronic obstructive pulmonary disease (COPD) dominate the list, reflecting the burden of communicable and non-communicable diseases among the elderly. These DRGs often correspond to emergency room admissions and high readmission rates, making them targets for CMS quality incentives. Their prominence also supports the need for investments in preventive healthcare, outpatient inter- ventions, and post-acute transitional care models to curb excessive inpatient reliance.

4.4 Payment-to-Charge Ratio

Figure 4 details the average Medicare payment-to-charge ratio (PCR) for all DRGs over the three-year period. The PCR remains consistently low, hovering between 18% and 24%. This suggests a systemic underpayment issue that does not align with the rising cost of care or inflation. A low PCR is critical for identifying inefficiencies in Medicare's prospec- tive

payment design and may prompt discussions on hybrid models or supplemental payments to offset financial losses in high-impact DRGs. It also helps quantify the magnitude of uncompensated care borne by hospitals.

4.5 DRG-Specific Comparisons

Figure 5 compares average submitted charges and Medi- care payments for a selected group of DRGs, including both high-volume and high-cost categories. The data reveal substantial variation in cost recovery across services. This comparison is vital to understand the imbalance between clinical effort and reimbursement received. By focusing on contrasting DRGs—some with acceptable margins and oth- ers with significant losses—we can identify specific oppor- tunities for DRG reclassification or advocacy for updated relative weights.

4.6 Yearly Trends for Top DRG

Figure 6 isolates septicemia—the most frequent DRG—for detailed analysis. Over three years, the submitted charges increased steadily due to inflation and complexity of cases, but Medicare payments remained largely unchanged. This trend illustrates a real-dollar decline in reimbursement and demonstrates the lag between clinical realities and financial recognition. The focus on one DRG allows a deeper dive into how operational pressures evolve over time. Sepsis care is both high-risk and high-cost, making it a bellwether for system-level challenges.

4.7 Inflation Adjustment and Revenue Loss

Figure 7 adjusts charge and payment data to 2023 dollars, revealing the growing gap in real value terms. Hospitals are effectively being reimbursed less over time when ad- justing for inflation, meaning their operating margins are eroding. Tracking inflation-adjusted revenue is crucial to un- derstanding the long-term viability of Medicare payments and highlights how financial distress is not merely anecdotal but data-driven. This figure quantifies how static DRG rates erode real value.

4.8 Geographic Variation and Reimbursement Trends

Figure 8 explores state-level discrepancies in Medicare re- imbursement. States with high cost-of-living indices like California and New York consistently receive lower-than- expected payments compared to peers. Exploring geo- graphic variation is essential to discussions on equitable access to care and highlights how national pricing models can distort reimbursement in high-expense areas. This fig- ure strengthens arguments for regional pricing reform and resource redistribution.

4.9 Clustering DRGs by Financial Profile

Figure 9 introduces an unsupervised machine learning ap- proach to classify DRGs into risk tiers. Using KMeans, DRGs were grouped into three clusters: 1) high-cost/low- pay, 2) moderate-cost/moderate-pay, and 3) low-cost/high- volume. This technique allows administrators to identify which service lines are at highest financial risk and target them for audit, resource optimization, or reimbursement

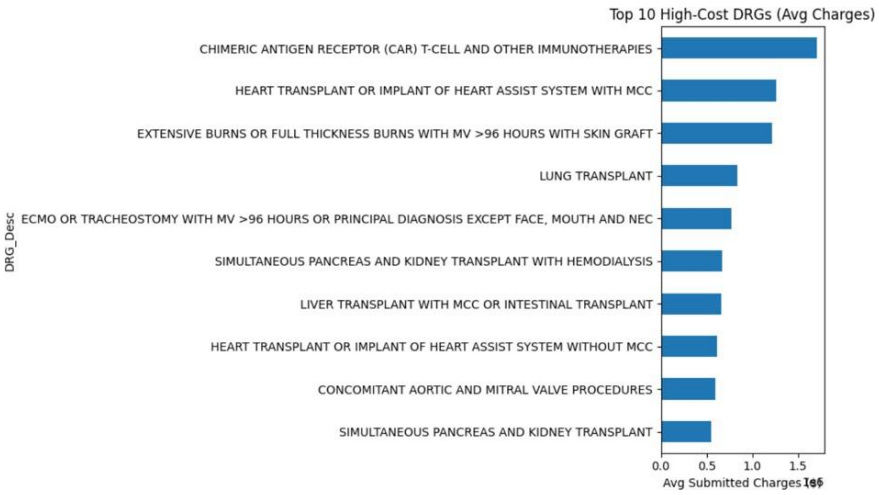

Fig. 1. Top 10 DRGs by Average Submitted Charges.

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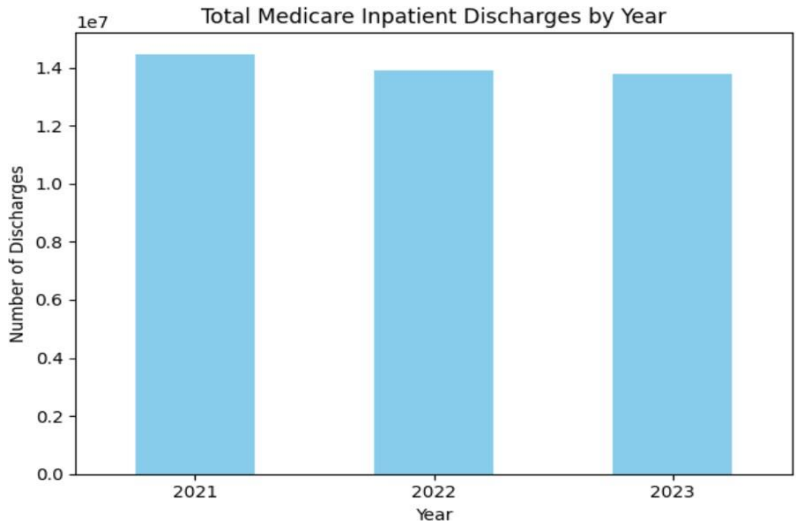

Fig. 2. Annual Inpatient Discharges from 2021–2023.

advocacy. From an analytics perspective, clustering enables segmentation of data into actionable policy cohorts and could inform future CMS initiatives around alternative payment models, predictive DRG management, and rate reviews.

5. POLICY IMPLICATIONS AND FUTURE WORK

Our findings suggest several implications for policymak- ers and healthcare executives. First, Medicare's static reimbursement rates do not account for inflation or rising care complexity, requiring more agile pricing models. Sec- ond, geographic disparities must be addressed to prevent unintended penalization of high-cost regions. Third, DRGs with high volume and low reimbursement may benefit from payment bundles or alternative value-based care models. Clustering insights also support realignment of DRG classi- fications based on actual hospital risk exposure.

Future work should integrate patient-level clinical out- comes with financial data to assess cost-effectiveness of reimbursement strategies. Additionally, DRG benchmarking across private payers could reveal how public pricing influences market behavior.

5.1 Conclusion

Looking at inpatient Medicare reimbursement over three years, a few things become very clear. First, hospitals that treat the sickest patients—those needing transplants, ex- tended ICU stays, or complex infection management—are consistently underpaid relative to what they charge. These gaps aren't just financial quirks; they reflect a deeper issue with how Medicare calculates payment weights under the current DRG system. Even as hospitals bounce back from the pandemic, the reimbursement structure hasn't kept pace with the rising costs of care delivery.

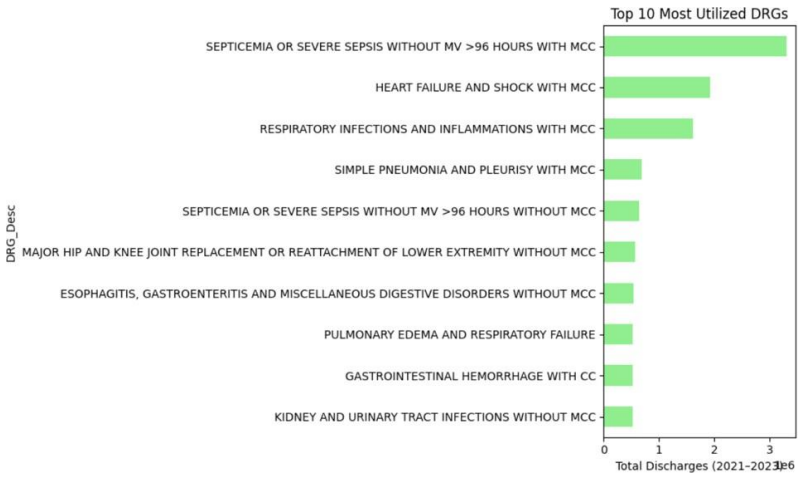

Fig. 3. Most Frequently Reported DRGs.

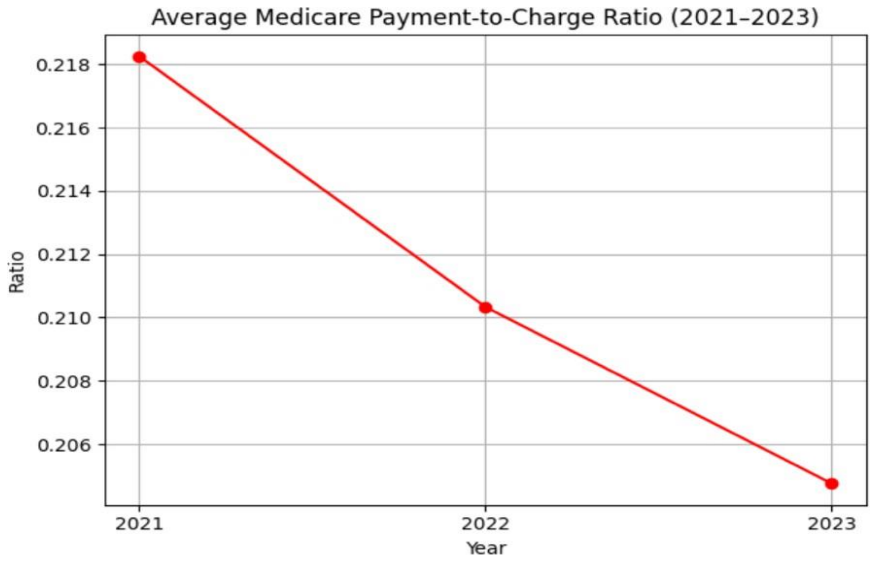

Fig. 4. Average Medicare Payment-to-Charge Ratio by Year.

What's especially concerning is the cluster of DRGs where this underpayment is most extreme. These services are both common and critical—think sepsis, COPD, or pneu- monia—but they're also the least profitable under Medicare. It's a dangerous combination that puts financial pressure on hospitals doing the most important work. Add to that the uneven reimbursements seen across different states, and it becomes clear that the payment system isn't as balanced or adaptive as it should be.

By applying a simple machine learning model to this data, we can start to see where the biggest financial risks lie. These insights can help hospitals plan better, advocate for smarter policy, and identify where reforms are most ur- gently needed. For policymakers, this study underscores the need for updates to DRG weightings, more accurate regional adjustments, and a serious look at how payment models can better reflect both care quality and complexity. This is about fairness, sustainability, and making sure hospitals are supported in doing what they do best—caring for patients.

Acknowledgment The data used in this research were sourced from the Centers for Medicare & Medicaid Services (CMS).

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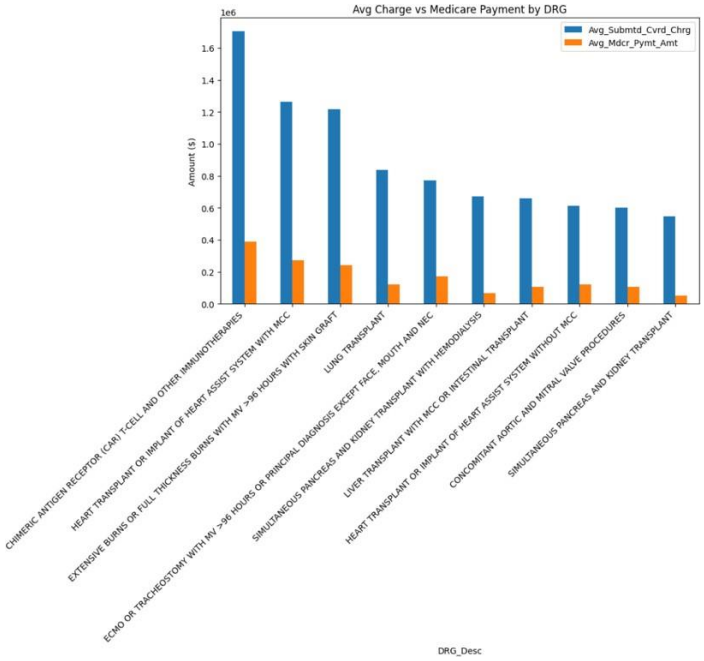

Fig. 5. Comparison of Charges vs Payments for Selected DRGs.

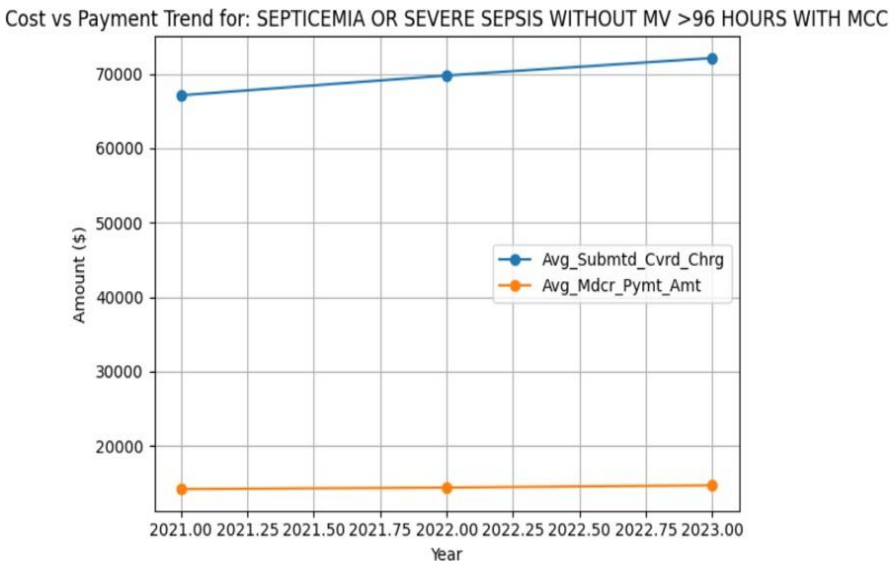

Fig. 6. Septicemia DRG Charges and Payments from 2021–2023.

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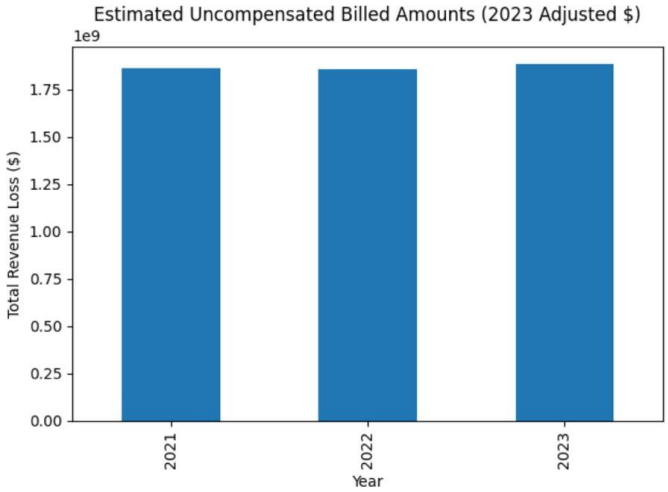

Fig. 7. Aggregate Revenue Loss Adjusted to 2023 Dollars.

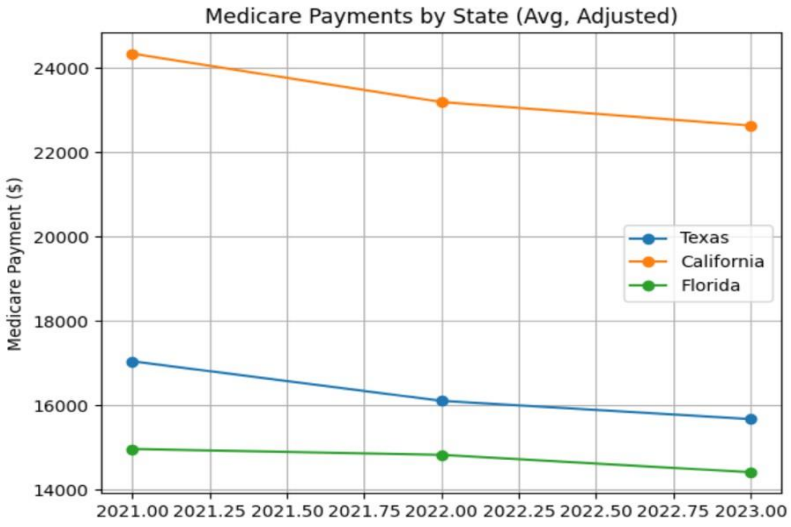

Fig. 8. Average Adjusted Payments in California, Texas, and Florida.

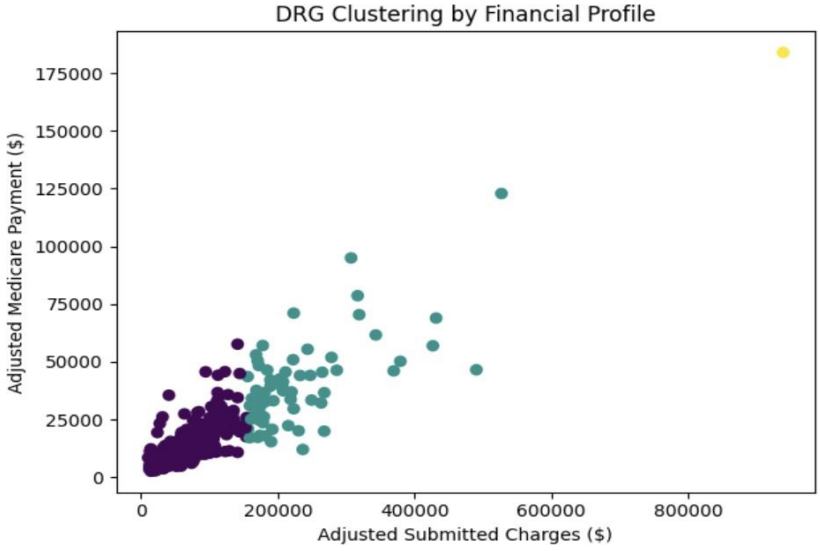

Fig. 9. DRG Financial Risk Clustering UsingKMeans.