DETAILED ANALYSIS REPORT

Medicare Fee-for-Service Carrier Claims Analysis

Revenue Cycle Operations (ROS) Analysis | 2022 Data

1. EXECUTIVE SUMMARY

This comprehensive analysis examines Medicare Part B (Carrier) claims data from 2022 to identify revenue cycle inefficiencies, payment delays, and systematic underpayment patterns. The analysis follows a structured operational framework focusing on line-level service transactions to quantify revenue leakage and process variability.

1.1 Key Performance Indicators

Metric	Value
Total Claims Analysed	174,411
Total Revenue Processed	$24.68M
Revenue Realisation Rate	77.8%
Total Revenue Leakage	$5.48M
Zero-Paid Rate	61.0%
Partial-Paid Rate	33.4%
Average Processing Time	4.0 days

1.2 Critical Findings

- Revenue Leakage: $5.48M (22.2% of allowed charges)
- Top 2 HCPCS codes (96156, 94010) account for 42% of total underpayment
- 61% of claim lines received zero payment (denial proxy)
- 75% of leakage stems from partial payments vs. 25% from denials
- All claims processed within 0-30 days (100% in first aging bucket)
- 12 high-risk services identified requiring immediate attention

2. PROJECT OVERVIEW & METHODOLOGY

2.1 Purpose & Scope

Purpose: This analysis focuses on operational revenue cycle questions rather than policy analysis. The goal is to understand how Medicare FFS physician claims behave at the transaction level, identify where money is lost or delayed, and detect patterns indicating process inefficiency or risk.

Scope:

- Medicare Fee-For-Service (Part B / Carrier claims)
- Line-level service transactions (HCPCS-based)
- Financial, timing, and processing indicators
- 2022 calendar year data only
- 174,411 claim lines after filtering and validation

2.2 Analytical Framework

The analysis follows a 6-step operational framework designed for Revenue Cycle Optimisation (ROS):

Step	Focus Area	Key Outputs
C1	Data Validation	Quality checks, assumptions documented
C2	Revenue Realization	Underpayment metrics, leakage drivers
C3	Denial Proxy Analysis	Zero-paid/partial-paid rates
C4	Delay & AR Analysis	Processing delays, AR aging buckets
C5	Variation Analysis	Stability metrics, CV analysis
C6	Outlier Detection	High-risk services, anomaly flags

2.3 Data Structure & Key Identifiers: Analytical Unit: Claim Line (LINE level)

Rationale:

- Revenue is realised per service (not per claim)
- Denials and underpayment occur at the line level
- Processing timing can vary per line within a claim

Key Identifiers:

- CLM_ID: Claim identifier
- LINE_NUM: Line number within claim
- HCPCS_CD: Healthcare Common Procedure Coding System code
- PRVDR_SPCLTY: Provider specialty code

3. STEP C1: DATA READINESS & VALIDATION

3.1 Data Loading & Initial Checks

The analysis began with 1,121,004 raw claim lines. Data was loaded from carrier01.csv with custom header handling to address the non-standard CSV format.

Initial Processing Steps:

- Loaded raw CSV without headers
- Set column names from row 2
- Dropped metadata rows (0 and 1)
- Reset index for clean line numbering

3.2 Uniqueness Validation

Verified that each (CLM_ID, LINE_NUM) combination represents a unique claim line:

Check	Result
Duplicate (CLM_ID, LINE_NUM) pairs	0 duplicates found

Conclusion: Each row represents a unique claim line transaction.

3.3 Financial Data Completeness

Checked for missing values in critical financial columns:

Column	Missing %
LINE_SBMTD_CHRG_AMT (Submitted)	0.0%
LINE_ALOWD_CHRG_AMT (Allowed)	0.0%
LINE_NCH_PMT_AMT (Paid)	0.0%
LINE_PRVDR_PMT_AMT (Provider Paid)	0.0%

Result: No missing values in mandatory financial columns. ✓

3.4 Financial Logic Consistency

Applied logical consistency rules:

- Submitted ≥ Allowed (payer considers reasonable amount)
- Allowed ≥ Paid (what was actually paid)
- Paid ≥ Provider Paid (provider portion)

Result: 99.86% of lines passed logical consistency checks

- Violations: 0.14% (1,585 lines)
- These lines were flagged and excluded from financial analysis

3.5 Date Validation

Converted & validated critical date fields:

- LINE_1ST_EXPNS_DT: Service date
- NCH_WKLY_PROC_DT: Processing date

Checks performed:

- Date format conversion: 0.0% parsing errors
- Logical order: Processing date ≥ Service date
- Result: 100% of lines have valid date logic ✓

3.6 Year Filtering

Filtered dataset to focus on the 2022 calendar year only for temporal consistency:

Metric	Value
Total rows (all years)	1,121,004
Rows after 2022 filter	174,645

3.7 HCPCS Code Validation

Finding: 62.2% of lines have missing HCPCS codes

Interpretation:

- This is common in Medicare data due to non-billable services or administrative lines
- Only 37.8% of lines have valid HCPCS codes for service-level analysis
- Service-specific analyses focus on the 37.8% with valid codes

3.8 Data Type Conversion

All financial columns were converted from object to float64:

- LINE_ALOWD_CHRG_AMT
- LINE_NCH_PMT_AMT
- LINE_SBMTD_CHRG_AMT
- LINE_PRVDR_PMT_AMT

3.9 Final Validated Dataset

After all validation steps:

- Financial analysis dataset: 174,411 lines (0.13% exclusion rate)
- All financial logic rules satisfied
- All dates valid and logically consistent
- Data ready for operational analysis

4. STEP C2: REVENUE REALIZATION & UNDERPAYMENT ANALYSIS

4.1 Core Business Questions

This analysis answers:

- Is revenue fully realised from allowed amounts?
- How severe is systematic underpayment?
- Which services contribute most to revenue leakage?
- What is the realisation efficiency by speciality?

4.2 Calculated Metrics

The following revenue cycle metrics were computed:

Metric	Formula / Definition
Underpayment Amount	Allowed - Paid
Realization Rate	(Paid / Allowed) × 100%
Gross-to-Net Ratio	(Provider Paid / Submitted) × 100%
Payment-to-Allowed Ratio	(Paid / Allowed) × 100%
Discount Rate	1 - (Allowed / Submitted)
Denial Rate	1 - (Paid / Allowed)

4.3 Overall Revenue Baseline Summary

Metric	Value
Total Submitted Charges	$24.68M
Total Allowed Amount	$24.68M
Total Payer (NCH) Paid	$19.20M
Total Provider Paid	$19.20M
Total Underpayment	$5.48M
Overall Realization Rate	77.8%
Total Processing Delay (days)	697,754
Gross-to-Net Ratio	77.8%
Payment-to-Allowed Ratio	77.8%
Net Collection Rate	77.8%
Discount Rate	0.0%
Denial Rate	22.2%

4.4 Key Insights from Overall Metrics

Critical Observations:

1. Submitted = Allowed ($24.68M): The discount rate is 0%, indicating Medicare sets allowed amounts equal to submitted charges for this dataset. This simplifies the revenue waterfall.
2. Revenue Realisation: Only 77.8% of allowed charges are actually paid, resulting in $5.48M underpayment (22.2% denial/adjustment rate).
3. Processing Efficiency: Average processing delay is 4.0 days per line, which is excellent and indicates efficient claims processing.

4.5 HCPCS-Level Analysis: Pareto Effect

Aggregated underpayment by HCPCS code to identify the primary drivers of revenue leakage.
Top 5 HCPCS Codes by Underpayment Amount:

HCPCS	Services	Allowed $	Paid $	Underpayment $	Real. Rate
96156	11,142	$5.65M	$4.48M	$1.17M	79.2%
94010	582	$5.35M	$4.24M	$1.12M	79.1%
99495	6,373	$3.75M	$2.97M	$0.79M	79.0%
G8839	1,346	$0.69M	$0.55M	$0.14M	79.2%
S9473	164	$0.37M	$0.29M	$0.08M	78.3%

CRITICAL FINDING: The top 2 HCPCS codes (96156 & 94010) account for $2.29M in underpayment, representing 42% of total revenue leakage. This demonstrates a classic Pareto effect.

4.6 Code Interpretation

HCPCS	Description	Clinical Context
96156	Health behavior assessment	Behavioral health services
94010	Spirometry	Respiratory/pulmonary function testing
99495	Transitional care mgmt	Post-discharge care coordination

4.7 Specialty-Level Analysis

Revenue realisation aggregated by provider speciality:

Specialty	Allowed $	Paid $	Underpayment $	Real. Rate
01	$98,093	$74,389	$23,704	75.8%
1	$24.58M	$19.13M	$5.46M	77.8%

Note: Speciality "1" represents the vast majority of claims (99.6% of allowed amount) with a consistent 77.8% realisation rate. Speciality "01" shows slightly lower realisation at 75.8%.

4.8 Underpayment Distribution Analysis

Statistical distribution of underpayment percentage:

Percentile	Underpayment %
Mean	25.2%
Median (50th)	20.0%
25th percentile	20.0%
75th percentile	20.0%
90th percentile	57.7%
Maximum	100.0%

Interpretation:

- 50% of lines have exactly 20% underpayment (median = 20.0%)
- Strong clustering around 20% suggests systematic adjustment pattern
- 10% of lines show severe underpayment >57.7%
- Some lines experience 100% underpayment (zero payment)

5. STEP C3: ZERO-PAID & PARTIAL-PAID ANALYSIS

5.1 Payment Outcome Categories

Each claim line was classified into one of three mutually exclusive categories:

Category	Logic	Interpretation
Zero-Paid	Paid = 0	Denial / non-payment proxy
Partial-Paid	0 < Paid < Allowed	Reduction/adjustment
Fully-Paid	Paid ≈ Allowed	Normal processing

5.2 Overall Payment Outcome Summary

Metric	Value
Total Claim Lines	1,121,004
Zero-Paid Lines	61.0%
Partial-Paid Lines	33.4%
Fully-Paid Lines	63.3%

CRITICAL INSIGHT: 61% of claim lines received zero payment, serving as a proxy for denial or non-billable services. However, 63.3% are fully paid, indicating the overlap is due to rounding tolerance (±$1).

5.3 Top HCPCS Codes by Zero-Paid Rate

Services with the highest denial proxy rates:

HCPCS	Total Lines	Zero-Paid	Zero Rate	Real. Rate
99401	3,337	3,337	100.0%	0.0%
G0442	3,368	3,368	100.0%	0.0%
G9572	323	323	100.0%	0.0%
G9573	328	328	100.0%	0.0%
99408	10,058	10,053	99.95%	0.08%

Interpretation:

- Four codes have 100% denial rates (no payments received)
- These are likely non-covered services or quality reporting codes
- Code 99408 (alcohol/substance abuse counselling) shows 99.95% denial

5.4 Leakage Attribution: Zero vs. Partial Payment

Breakdown of $5.48M total underpayment by category:

Category	Underpayment $	Share of Total
Zero-Paid Lines	$1.37M	25.0%
Partial-Paid Lines	$4.11M	75.0%

KEY FINDING: 75% of revenue leakage comes from partial payments (adjustments/reductions) rather than outright denials. This suggests that reducing partial payment rates (improving to full realization) presents the largest opportunity for revenue recovery.

5.5 Speciality-Level Denial Patterns

Specialty	Total Lines	Zero-Paid %	Partial-Paid %
01	975	74.9%	20.9%
1	173,436	60.9%	33.4%

Speciality "01" shows a higher zero-paid rate (74.9%) vs. speciality "1" (60.9%), indicating potential coding or billing process differences.

6. STEP C4: DELAY & AR PROXY ANALYSIS

6.1 Processing Delay Definition

Processing Delay = NCH_WKLY_PROC_DT - LINE_1ST_EXPNS_DT (in days)
This metric serves as an Accounts Receivable (AR) proxy, measuring how long it takes from service date to payment processing.

6.2 Overall Delay Statistics

Statistic	Days
Mean	4.0
Median	4.0
25th Percentile	2.0
75th Percentile	6.0
90th Percentile	7.0
95th Percentile	7.0
Maximum	8.0

EXCELLENT PERFORMANCE: Average processing time of 4 days is outstanding. All claims are processed within 8 days, indicating highly efficient claims adjudication processes.

6.3 AR Aging Distribution

AR Bucket	Claim Lines	Allowed $	Revenue Share
0-30 days	174,411	$24.68M	100.0%
31-60 days	0	$0	0.0%
61-90 days	0	$0	0.0%
91-180 days	0	$0	0.0%
>180 days	0	$0	0.0%

Result: 100% of claims fall in the 0-30 day bucket. There is no aged AR in this dataset, indicating no cash flow concerns from delayed processing.

6.4 HCPCS-Level Delay Analysis

Top 5 services by median processing delay:

HCPCS	Lines	Avg Delay	Median	P90
G8440	1	7.0	7.0	7.0
G9530	1	7.0	7.0	7.0
G8942	4	6.8	6.5	7.7
G8159	4	5.3	6.5	7.0
C8923	3	4.3	6.0	6.0

Even the slowest-processing codes have median delays of only 6-7 days, which is still excellent.

6.5 Denial Code Analysis

Analysis of CARR_CLM_PMT_DNL_CD (claim payment denial code):

Denial Code	Count	Underpayment $	Allowed $
1	173,436	$5.46M	$24.58M
01	975	$23,704	$98,093

Note: Denial code "1" is not a standard Medicare denial reason code. This requires further investigation with the data dictionary to understand its meaning in this context.

6.6 Top Diagnoses in Denied Claims

Most common principal diagnosis codes in denied claims:

Diagnosis Code	Frequency
Z733 (Stress reaction)	257
Z608 (Other counselling)	228
T7432X (Nicotine dependence)	143
S6290X (Unspecified fracture)	67
Z604 (Substance abuse counselling)	46

Pattern: Many denied claims involve counselling, stress, and substance abuse diagnoses, suggesting possible coverage limitations for behavioural health services.

7. STEP C5: VARIATION & CONSISTENCY ANALYSIS

7.1 Purpose

This analysis examines process stability by measuring variation in underpayment rates and processing delays across services. High variation indicates inconsistent outcomes and potential process control issues.

7.2 Coefficient of Variation (CV)

CV = Standard Deviation / Mean

Computed for each HCPCS code:

- CV of Underpayment %: Consistency of payment realization
- CV of Processing Delay: Consistency of timing

7.3 Sample Variation Metrics

HCPCS	Lines	Mean Underpay %	Std Dev	CV Underpay	CV Delay
71046	22	20.0%	0.195	0.976	0.474
77080	27	18.3%	0.195	1.063	0.425
96127	143	18.2%	0.060	0.332	0.413
96156	11,142	19.6%	0.184	0.939	0.472
94010	582	20.7%	0.185	0.894	0.524

Interpretation:

- CV > 1.0 indicates high variability (e.g., 77080 at 1.063)
- CV < 0.5 indicates good consistency (e.g., 96127 at 0.332)
- Most codes show moderate variation (0.4-1.0 range)

8. STEP C6: OUTLIER DETECTION & RISK FLAGGING

8.1 Methodology

Used the Interquartile Range (IQR) method for outlier detection:

- Underpayment outliers: Mean > Q3 + 1.5 × IQR
- Delay outliers: Mean > Q3 + 1.5 × IQR
- High CV outliers: CV > 90th percentile

8.2 High-Risk Services Identified

HCPCS	Lines	Mean Underpay %	CV Underpay	Mean Delay	CV Delay	Underpay Flag	Delay Flag
G8939	3	46.7%	0.990	5.3	0.217	YES	NO
G8434	3	40.0%	1.323	2.3	0.990	YES	NO
QS	11	30.9%	1.134	5.2	0.447	YES	NO
S0605	34	24.2%	0.898	4.1	0.458	NO	NO
99497	9	20.0%	0.000	3.8	0.618	NO	NO
C8923	3	20.0%	0.000	4.3	0.666	NO	NO
G8942	4	20.0%	0.000	6.8	0.142	NO	YES
C8929	2	20.0%	0.000	3.0	0.943	NO	NO
G9530	1	20.0%	N/A	7.0	N/A	NO	YES
77080	27	18.3%	1.063	4.3	0.425	NO	NO
71046	22	20.0%	0.976	4.5	0.474	NO	NO
96127	143	18.2%	0.332	4.0	0.413	NO	NO

8.3 Risk Priority Matrix

Services classified by priority based on volume and financial impact:

HCPCS	Services	Underpayment $	Real. Rate	Priority
96156	11,142	$1.17M	79.2%	P1-Critical
94010	582	$1.12M	79.1%	P1-Critical
99495	6,373	$0.79M	79.0%	P1-Critical
G8839	1,346	$0.14M	79.2%	P1-Critical
S9473	164	$0.08M	78.3%	P1-Critical

Priority Definitions:

- P1-Critical: High volume AND high dollar impact
- P2-High: High volume OR high dollar impact
- P3-Monitor: Lower volume and impact, but still tracked

9. EXECUTIVE INSIGHTS & RECOMMENDATIONS

9.1 Summary of Findings

1. Revenue Leakage Magnitude
    - **$5.48M in underpayment (22.2% of allowed charges)**

2. Pareto Concentration
    - **Top 2 codes account for 42% of total leakage**

3. Payment Pattern Analysis
    - **75% of leakage from partial payments vs. 25% from denials**

4. Processing Efficiency
    - **Excellent: 4-day average processing time, no aged AR**

5. Systematic Patterns
    - Strong clustering around 20% underpayment rate suggests a systematic adjustment policy

9.2 Root Cause Analysis

Based on the data, the following root causes are hypothesised:

Behavioural Health Coverage Limitations

- Codes 96156 (health behaviour assessment) and 99408 (substance abuse counselling) show high denial/underpayment rates. Diagnosis patterns (Z733, Z608, T7432X) suggest behavioural health services face coverage restrictions.

Systematic 20% Adjustment Policy

- The strong concentration at exactly 20% underpayment (median, 25th, and 75th percentiles) indicates a systematic Medicare adjustment policy, likely related to coinsurance or cost-sharing.

Service-Specific Reimbursement Rules

- Codes G0442, G9572, G9573, and 99401 have 100% denial rates, suggesting they are non-covered quality reporting codes or services requiring different billing procedures.

9.3 Actionable Recommendations

Immediate Actions (0-30 days):

1. Investigate Top 2 Codes: Deep dive into billing practices for 96156 and 94010 to identify opportunities for reducing the 21% underpayment rate.
2. Review Zero-Paid Codes: Determine if codes with 100% denial (G0442, G9572, etc.) should be billed differently or discontinued to reduce administrative burden.
3. Validate Denial Code "1": Clarify the meaning of denial code "1" using CMS documentation to understand whether these represent true denials or data artifacts.

Short-Term Actions (30-90 days):

1. Optimise Partial Payment Recovery: Focus on the 33.4% of partial-paid lines, which represent $4.11M in leakage. Even a 10% improvement would recover $411K.
2. Develop Service-Specific Guidelines: Create billing and coding guidelines for high-risk services (especially behavioural health) to improve realisation rates.
3. Implement Monitoring Dashboard: Set up automated tracking of realisation rates by HCPCS code to detect emerging patterns quickly.

Long-Term Actions (90+ days):

1. Negotiate Payer Contracts: Use this data to support negotiations with Medicare or Medicare Advantage plans regarding reimbursement rates for high-volume services.
2. Process Standardisation: Address variation in underpayment rates (high CV services) through standardised coding and billing procedures.
3. Predictive Analytics: Build predictive models to identify claims at high risk of denial or partial payment before submission.

9.4 Estimated Financial Impact

Opportunity	Basis	Potential Recovery
Partial Payment Optimization	10% improvement on $4.11M	$411,000
Top 2 Code Improvement	5% improvement on $2.29M	$114,500
Process Standardization	Reduce variation-related losses	$50,000-$100,000
TOTAL OPPORTUNITY		$575,000-$625,000

Conservative Estimate: $575K-$625 annual revenue recovery opportunity represents 10.5-11.4% of the current $5.48M leakage.

10. TECHNICAL APPENDIX

10.1 Data Sources & Files

Input Data:

- carrier01.csv: Raw Medicare Carrier claims data
- Original rows: 1,121,004
- Columns: 96 variables, including financial, clinical, and administrative data

Output Files Generated:

- carrier_01.csv: Cleaned 2022 dataset
- hcpcs_underpayment_summary.csv: Service-level revenue metrics
- specialty_realization_summary.csv: Specialty-level analysis
- hcpcs_denial_proxy_summary.csv: Denial rate analysis
- leakage_breakdown.csv: Zero vs. partial payment attribution
- hcpcs_delay_summary.csv: Processing time analysis
- overall_ar_profile.csv: AR aging distribution
- hcpcs_variation_outliers.csv: Stability metrics
- high_risk_services.csv: Flagged outliers
- RCM_Analysis_Final.xlsx: Executive presentation workbook

10.2 Tools & Technologies

Component	Technology
Programming Language	Python 3.x
Data Analysis	Pandas, NumPy
Visualization	Matplotlib, Seaborn
Statistical Analysis	SciPy (implied)
Environment	Google Colab
Output Format	CSV, XLSX, PNG (visualizations)

10.3 Key Code Descriptions

HCPCS Code	Description
96156	Health behavior assessment, each 15 minutes
94010	Spirometry (respiratory function test)
99495	Transitional care management, 14 days
G8839	Sleep apnea symptoms assessed
S9473	Pulmonary rehabilitation
99401	Preventive medicine counseling, 15 minutes
G0442	Annual alcohol screening, 15 minutes
99408	Alcohol and/or substance abuse counseling
G9572	Quality measure - not eligible
G9573	Quality measure - not eligible

10.4 Limitations & Caveats

1. Single Year Analysis
    - Data limited to 2022 calendar year. Trends over time cannot be assessed.

2. Synthetic/Sample Data
    - Analysis uses CMS Public Use Files (PUF), which may be synthetic or sampled, potentially limiting generalizability to the actual population.

3. Missing HCPCS Codes
    - 62.2% of lines lack HCPCS codes, restricting service-level granularity for the majority of data.

4. Denial Code Ambiguity
    - Denial code "1" requires verification against data dictionary for proper interpretation.

5. No Provider-Level Analysis
    - Analysis aggregates at service and speciality levels; individual provider performance is not assessed.

6. No Clinical Context
    - Operational analysis only; does not evaluate medical necessity, appropriateness, or quality of care.

11. CONCLUSION

This comprehensive Revenue Cycle Operations analysis of 174,411 Medicare Part B claim lines from 2022 reveals significant revenue leakage totalling $5.48 million (22.2% of allowed charges). The analysis successfully identified systematic patterns, high-risk services, and actionable opportunities for revenue optimisation.

Key Achievements:

✓ Validated and cleaned 100% of financial data with rigorous logic checks
✓ Identified Pareto concentration: Top 2 codes drive 42% of leakage
✓ Quantified denial vs. adjustment impact: 75% partial payment, 25% zero payment
✓ Confirmed excellent processing efficiency: 4-day average, 100% within 30 days
✓ Flagged 12 high-risk services requiring targeted intervention
✓ Estimated $575K-$625K annual recovery opportunity (10.5-11.4% of leakage)

Document Prepared By:

Abhinav Verma
abhinav.ha01@gmail.com