**🎯 Use case: “Outlier & Aberrant Billing Finder” (MCP‑orchestrated)**

**Goal:** Pre- and post‑pay triage of professional and facility claims to (1) flag high‑risk outliers (e.g., upcoding, unbundling, excessive units), (2) explain “why” with policy‑anchored evidence, and (3) auto-package auditable case files for SIU/review teams.

**Why MCP?**

MCP standardizes how the agent connects to **multiple, heterogeneous context sources and tools**. Your LLM agent becomes the conductor: it fetches coverage rules, calls ML models, runs rules checks, pulls provider registries, and drafts investigator-ready rationales—all through uniform “resources” and “tools.” [[1]](https://modelcontextprotocol.io/specification/2025-03-26/index)[[2]](https://www.anthropic.com/news/model-context-protocol)

**🔗 External context & rules the agent should use (with citations)**

1. **Correct Coding Policies (NCCI)**
   * **PTP edits** to catch **unbundling/mutually-exclusive codes** and **MUEs** to cap **units-of-service** on a DOS. CMS updates these quarterly, and publishes a 2025 policy manual. [[3]](https://www.cms.gov/medicare/coding-billing/ncci-medicare)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)[[5]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-policy-manual)
2. **Coverage policy (LCD/NCD) text & lookups**
   * Use CMS’s **Medicare Coverage Database** for NCD/LCD retrieval and search. [[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)
3. **Provider identity & specialty**
   * **NPPES NPI Registry API** for taxonomy, addresses, organization vs individual, etc. [[7]](https://npiregistry.cms.hhs.gov/api-page)
4. **Exclusions (LEIE) & sanctions**
   * **HHS‑OIG LEIE** searchable/downloadable database; updated monthly (good for pre‑pay blocks and post‑pay flags). [[8]](https://exclusions.oig.hhs.gov/)[[9]](https://www.careproviders.org/CPM/CPM/ACTION/Vol40/Ed36/ZP13.aspx)
5. **Program integrity baselines**
   * For context, Medicare FFS improper payment rate FY2024 ≈ **7.66% ($31.7B)**; your KPIs should show reduction vs this macro baseline. [[10]](https://www.cms.gov/newsroom/fact-sheets/fiscal-year-2024-improper-payments-fact-sheet)[[11]](https://www.cms.gov/data-research/monitoring-programs/improper-payment-measurement-programs/comprehensive-error-rate-testing-cert/improper-payment-rates-and-additional-data)
6. **Telehealth policy nuances** (to avoid false positives)
   * CMS maintains the **telehealth eligible services list** for CY2025; audio‑only is allowed under certain conditions in home settings (be mindful in POS/modifier checks). [[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)[[13]](https://www.cchpca.org/2024/11/CY-2025-PFS-FINAL.pdf)[[14]](https://telehealthresourcecenter.org/resources/fact-sheets/final-physician-fee-schedule-pfs-cy-2025-factsheet/)

**🧠 Modeling blueprint (hybrid)**

You have labels—great for supervised learning. Add **unsupervised/graph** layers to catch novel patterns and provider networks.

1. **Supervised core (primary classifier)**
   * **LightGBM/XGBoost** on claim-line and episode features for fraud/waste/abuse propensity.
   * Handle extreme imbalance (focal loss or class‑weighting; thresholding by investigator capacity).
2. **Unsupervised outlier layers**
   * **Isolation Forest / LOF** on per‑provider time series for **volume/units** spikes;
   * **Autoencoder** for claim‑vector reconstruction error (detect emerging patterns).
3. **Graph-based signals**
   * **Provider–patient–procedure graph**: compute **node embeddings** (Node2Vec/GraphSAGE) and **centrality**; flag **unusual referral or DME supply chains**.
4. **Rule & policy checks (hard gates)**
   * NCCI **PTP** and **MUE** validations, **modifier logic** (e.g., 25, 59), and **telehealth** code/POS consistency to yield **explainable rationales**. [[3]](https://www.cms.gov/medicare/coding-billing/ncci-medicare)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)[[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)
5. **Provider integrity checks**
   * **LEIE** hit = high‑severity block/route; **NPPES** taxonomy mismatch raises risk weight. [[8]](https://exclusions.oig.hhs.gov/)[[7]](https://npiregistry.cms.hhs.gov/api-page)
6. **Explainability & governance**
   * **SHAP** for model explanations; retain **policy snippets** (NCCI/LCD) as citations in the case packet for audit defensibility. [[5]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-policy-manual)[[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)

**🧱 MCP architecture (high level)**

**MCP Client (agent)** hosted in your secure environment\ **MCP Servers** expose tools/resources the agent can call:

{

  "servers": [

    {

      "name": "claims-warehouse",

      "resources": [

        {"uri": "sql://databricks/claims", "description": "Claims & adjudication tables"},

        {"uri": "sql://databricks/providers", "description": "Provider master / panels"}

      ],

      "tools": [

        {"name": "run*sql", "inputSchema": {"sql": "string", "params": "object"}}*

*]*

*},*

*{*

*"name": "cms-ncci",*

*"resources": [*

*{"uri": "https://www.cms.gov/medicare/coding-billing/ncci-medicare", "description": "PTP rules & manuals"},*

*{"uri": "https://www.cms.gov/medicare/coding-billing/ncci-medically-unlikely-edits", "description": "MUE tables"}*

*],*

*"tools": [*

*{"name": "ptp*check", "inputSchema": {"hcpcs": "string[]", "dos": "string"}},

        {"name": "mue*check", "inputSchema": {"hcpcs": "string", "uom": "number", "dos": "string"}}*

*]*

*},*

*{*

*"name": "coverage-policy",*

*"resources": [*

*{"uri": "https://www.cms.gov/medicare-coverage-database/search.aspx", "description": "NCD/LCD"}*

*],*

*"tools": [*

*{"name": "lookup*lcd", "inputSchema": {"code": "string", "mac": "string"}}

      ]

    },

    {

      "name": "provider-identity",

      "tools": [

        {"name": "npi*lookup", "inputSchema": {"npi": "string"}},   // NPPES API*

*{"name": "leie*check", "inputSchema": {"npi": "string", "name": "string"}} // OIG LEIE

      ]

    },

    {

      "name": "models",

      "tools": [

        {"name": "score*supervised", "inputSchema": {"claim*ids": "string[]"}},

        {"name": "score*outlier", "inputSchema": {"provider*id": "string", "window*days": "number"}},*

*{"name": "graph*score", "inputSchema": {"provider*id": "string"}}*

*]*

*},*

*{*

*"name": "case-management",*

*"tools": [*

*{"name": "open*case", "inputSchema": {"subject": "string", "body": "string", "attachments": "string[]"}}

      ]

    }

  ]

}

* MCP lets the agent **compose** these calls, combine **Resources** with **Tools**, and produce a **traceable, policy-cited output** for reviewers. [[1]](https://modelcontextprotocol.io/specification/2025-03-26/index)

**🧪 Detection logic the agent will follow (simplified)**

1. **Fetch cohort**: Daily incremental claims (pre‑ or post‑adjudication).
2. **Run rules**:
   * PTP/MUE checks (hard fails/soft flags). [[3]](https://www.cms.gov/medicare/coding-billing/ncci-medicare)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)
   * Telehealth consistency (HCPCS ↔ POS ↔ modifiers; allow audio‑only where policy permits). [[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)[[13]](https://www.cchpca.org/2024/11/CY-2025-PFS-FINAL.pdf)
3. **Provider vetting**: NPPES taxonomy confirmation, LEIE exclusion. [[7]](https://npiregistry.cms.hhs.gov/api-page)[[8]](https://exclusions.oig.hhs.gov/)
4. **ML scoring**: Return **P(fraud/waste/abuse)**, **outlier scores**, and **graph anomaly**.
5. **Evidence building**:
   * Attach **policy excerpts** (LCD/NCCI) and **explanations** (SHAP top features). [[5]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-policy-manual)[[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)
6. **Triage & case open**: Top‑K by **expected recovery = score × allowed\_amt**; auto‑draft investigator packet.

**🧩 Feature ideas (claim-, provider-, & policy-aware)**

* **Claim-line**: HCPCS/CPT, modifiers (e.g., **25**, **59**), units, POS, revenue code, allowed/paid, prior auth, Dx bundle. (Modifier 25 is often misused; keep explicit patterns & peer benchmarks.) [[15]](https://www.cms.gov/outreach-and-education/medicare-learning-network-mln/mlnmattersarticles/downloads/se17017.pdf)[[16]](https://oig.hhs.gov/reports/all/2025/medicare-payments-for-evaluation-and-management-services-provided-on-the-same-day-as-eye-injections-were-at-risk-for-noncompliance-with-medicare-requirements/)
* **Episode**: rolling **units/day** caps, **frequency** vs MUEs, proximity of related codes violating PTP. [[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)[[3]](https://www.cms.gov/medicare/coding-billing/ncci-medicare)
* **Provider**: specialty taxonomy (NPPES), historical peer z‑scores by HCPCS, unusual growth, weekend/holiday density, LEIE status. [[7]](https://npiregistry.cms.hhs.gov/api-page)[[8]](https://exclusions.oig.hhs.gov/)
* **Coverage alignment**: LCD/NCD match/mismatch (local coverage nuances cause regional variation). [[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)
* **Telehealth**: code‑POS consistency, audio‑only eligibility, frequency limits suspensions as applicable. [[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)[[14]](https://telehealthresourcecenter.org/resources/fact-sheets/final-physician-fee-schedule-pfs-cy-2025-factsheet/)

**📦 Example: agent’s investigator packet (auto‑generated)**

* **Summary**: “Provider NPI 123… flagged for high outlier rate on 99213‑25 + 20610 combos; 3.2× peer rate; $Y expected.”
* **Model explanation**: SHAP top features (units, modifiers, POS, prior denials).
* **Policy evidence**:
  + NCCI guidance on unbundling, **modifier 25** and related examples (PTP context). [[5]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-policy-manual)[[15]](https://www.cms.gov/outreach-and-education/medicare-learning-network-mln/mlnmattersarticles/downloads/se17017.pdf)
  + **MUE** exceedance details with quarter/version. [[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)
  + Any LCD citations relevant to the MAC region. [[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)
* **Identity & exclusions**: NPPES taxonomy snapshot; LEIE check results. [[7]](https://npiregistry.cms.hhs.gov/api-page)[[8]](https://exclusions.oig.hhs.gov/)
* **Telehealth** (if applicable): how code aligns with CMS telehealth list (CY2025), including audio‑only if used. [[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)[[13]](https://www.cchpca.org/2024/11/CY-2025-PFS-FINAL.pdf)

**📏 Measurement & guardrails**

* **Primary KPIs**:
  + **Precision\@K** (by SIU capacity), **Net recovery per review hour**, **False‑positive rate** on QA samples.
  + **Time‑to‑detection** vs historical.
  + Benchmark against **FFS improper payment** rates for directional validation. [[10]](https://www.cms.gov/newsroom/fact-sheets/fiscal-year-2024-improper-payments-fact-sheet)
* **Calibration**: Calibrated probabilities (Platt/Isotonic); decision threshold set to **investigator bandwidth**.
* **Fairness & drift**:
  + Monitor specialty/geography bias; policy change drift (e.g., telehealth list, NCCI quarterly files). [[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)
* **Compliance**: HIPAA/PHI handling; BAA; full **MCP call logs** & evidence snapshots for audit.

**🧪 Example MCP “reasoning plan” prompt (agent side)**

You are a payment-integrity analyst agent. For the input claim*ids:*

*1) Call models.score*supervised and models.score*outlier (provider scope).*

*2) Run cms-ncci.ptp*check and cms-ncci.mue*check on each claim-line.*

*3) If POS=home or telehealth modifiers present, consult coverage-policy and telehealth list.*

*4) Resolve provider via provider-identity.npi*lookup; screen via provider-identity.leie*check.*

*5) Build a rationale with:*

*- Model scores + top SHAP features*

*- Policy snippets (NCCI/LCD URLs with chapter references)*

*- Any telehealth eligibility notes (CY2025 list)*

*6) Open a case via case-management.open*case including CSV of flagged lines, SHAP plot, and policy citations.

Return a concise triage table and a narrative summary.

**🛠️ Data & model scaffolding (illustrative)**

**Entity resolution** (dedupe NPIs/TINs), **temporalization** (DOS buckets), **label hygiene** (confirmed SIU outcomes, post‑payment recoveries, appeal outcomes). Build per‑provider **rolling windows** (7/30/90 days) for volume & units; join **NPPES** for taxonomy; ingest **NCCI** (PTP/MUE) quarterly; index LCD/NCD text with IDs for retrieval. [[7]](https://npiregistry.cms.hhs.gov/api-page)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)[[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)

**🚀 6–8 week pilot plan (pragmatic)**

1. **Week 1–2** – Data access & policy connectors
   * Land **claims**, **SIU labels**, **NPPES**, **LEIE**, **NCCI** public files; spin up MCP servers for **rules**, **coverage**, **identity**. [[7]](https://npiregistry.cms.hhs.gov/api-page)[[8]](https://exclusions.oig.hhs.gov/)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)
2. **Week 2–4** – Baseline models & rules
   * Train LightGBM; add IsolationForest; wire **PTP/MUE** tools; validate on last 12 months. [[3]](https://www.cms.gov/medicare/coding-billing/ncci-medicare)
3. **Week 4–5** – Agent assembly
   * MCP orchestration, prompt templates, case packet generation with citations. [[1]](https://modelcontextprotocol.io/specification/2025-03-26/index)
4. **Week 6–8** – Shadow mode & evaluation
   * Compare **Precision\@K**, **yield**, investigator time saved; finalize go/no‑go.

**🔐 Risk & compliance notes**

* Keep **PHI** within your VPC; MCP servers run **inside** your network; outbound calls to CMS public resources are non‑PHI.
* **Monthly** refresh of LEIE; **quarterly** refresh of NCCI PTP/MUE; **annual** PFS/telehealth updates to avoid policy drift. [[9]](https://www.careproviders.org/CPM/CPM/ACTION/Vol40/Ed36/ZP13.aspx)[[4]](https://www.cms.gov/medicare/coding-billing/national-correct-coding-initiative-ncci-edits/medicare-ncci-medically-unlikely-edits)[[12]](https://www.cms.gov/medicare/coverage/telehealth/list-services)

**Want me to jump-start this?**

I can:

* Draft the **feature catalog** aligned to your schemas and labels,
* Provide a **starter MCP server** for NCCI/LCD/NPPES/LEIE,
* Ship a **baseline LightGBM** with calibration and **SHAP‑based** explanation templates,
* Stand up a **triage dashboard** (Precision\@K, yield, investigator capacity).

**A couple of quick inputs would help me tailor it:**

1. Which lines of business are we targeting first—**MA, Medicaid, commercial, or FFS**? (LCD/NCD application varies by MAC/region.) [[6]](https://www.cms.gov/medicare-coverage-database/search.aspx?from=Overview)
2. Is your first deployment **pre‑pay**, **post‑pay**, or both (different latency and precision targets)?
3. Are we cleared to call **public CMS endpoints** from within your network, and to cache quarterly **NCCI** files? [[3]](https://www.cms.gov/medicare/coding-billing/ncci-medicare)

Given your interest in **agentic AI**, this MCP approach not only boosts detection accuracy but also **grounds the agent’s reasoning in the exact CMS rules** investigators already trust—reducing friction and **speeding recoveries**.

**References**

[1] [modelcontextprotocol.io](https://modelcontextprotocol.io/specification/2025-03-26/index)

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[3] [www.cms.gov](https://www.cms.gov/medicare/coding-billing/ncci-medicare)

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[9] [www.careproviders.org](https://www.careproviders.org/CPM/CPM/ACTION/Vol40/Ed36/ZP13.aspx)

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[12] [www.cms.gov](https://www.cms.gov/medicare/coverage/telehealth/list-services)

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[16] [oig.hhs.gov](https://oig.hhs.gov/reports/all/2025/medicare-payments-for-evaluation-and-management-services-provided-on-the-same-day-as-eye-injections-were-at-risk-for-noncompliance-with-medicare-requirements/)