Timely & Effective Care — Hospital Quality, Explained with Data

Churamani Paudel

August 23, 2025

An opinionated, reproducible walkthrough for hospital quality analysis.

TL;DR

We analyze hospital “Timely & Effective Care” metrics and show how to turn raw observations into actionable insight: distribution, geographic spread, trend, composite scoring, funnel plots for statistical significance, and rank stability across quarters.

Data & Preparation

Data columns used in this demo: Hospital, State, Measure (ID & name), Period (quarter), Rate (%), Patients (count per observation), Beds (hospital size proxy), and SystemAffiliated (0/1).

Preprocessing steps:

- Convert rates to %-scale and coerce numeric types.
- Trim impossible values and bound rates to [0, 100].
- Aggregate per hospital/measure/period as needed.
- For composites, standardize per-measure within each period to ensure comparability.

Math that Matters

Composite scoring with z-scores:

$z_{i,m,t} = \frac{r_{i,m,t} - \mu_{m,t}}{\sigma_{m,t}}$, $S_{\text{state}} = \mathrm{Mean}_{t}\big(\mathrm{Mean}_{i\in \text{state}}(z_{i,m,t})\big)$\n\nFunnel-plot bands (normal approx. for binomial proportion):

$\hat{p} = \mathrm{mean}(r/100)$, $\mathrm{SE}(\hat{p}) \approx \sqrt{\hat{p}(1-\hat{p})/n}$, $95\%~\mathrm{CI} = \hat{p} \pm 1.96\cdot \mathrm{SE}$.

EDA Roadmap

We inspect: (1) the overall distribution of rates, (2) spread by state, (3) top hospitals, (4) time trends, and (5) cross-sectional variation by measure × state. The funnel plot distinguishes true signals from small-sample noise, and the rank-stability view checks whether quarter-to-quarter performance is consistent.

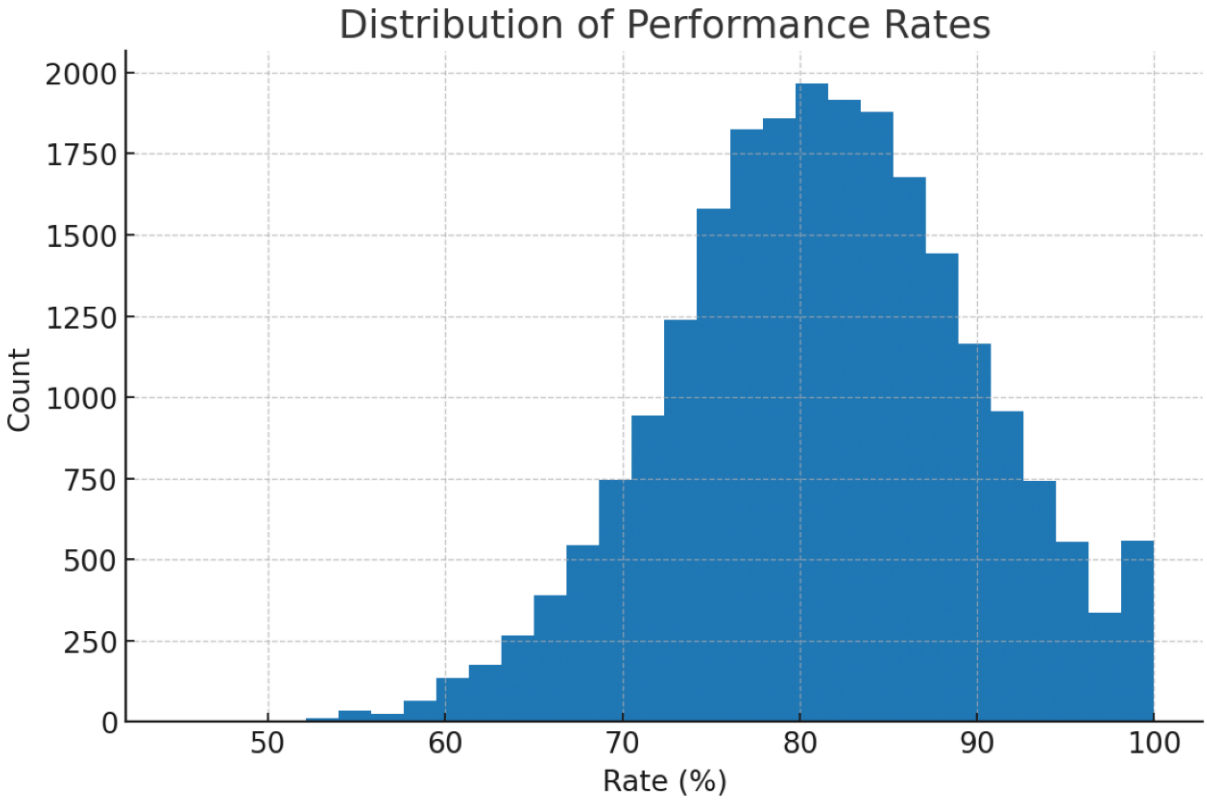

Figure 1 — Distribution of performance rates across all observations.

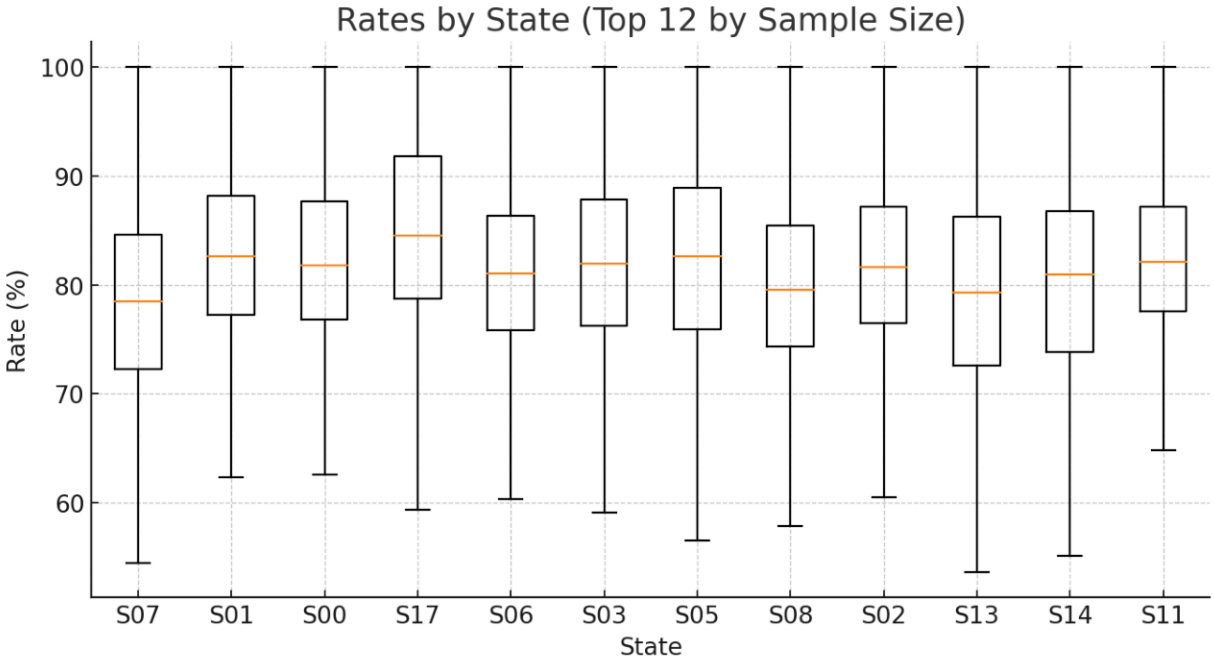

Figure 2 — Rates by state (top 12 by sample size).

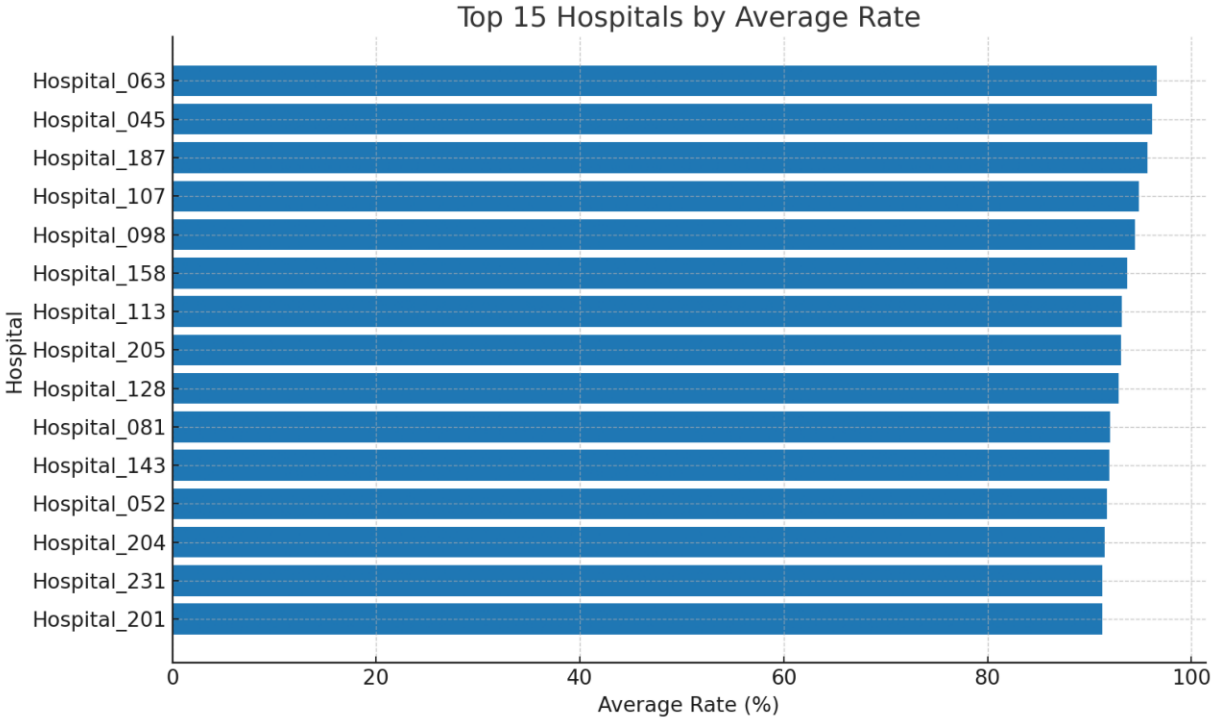

Figure 3 — Top 15 hospitals by average rate.

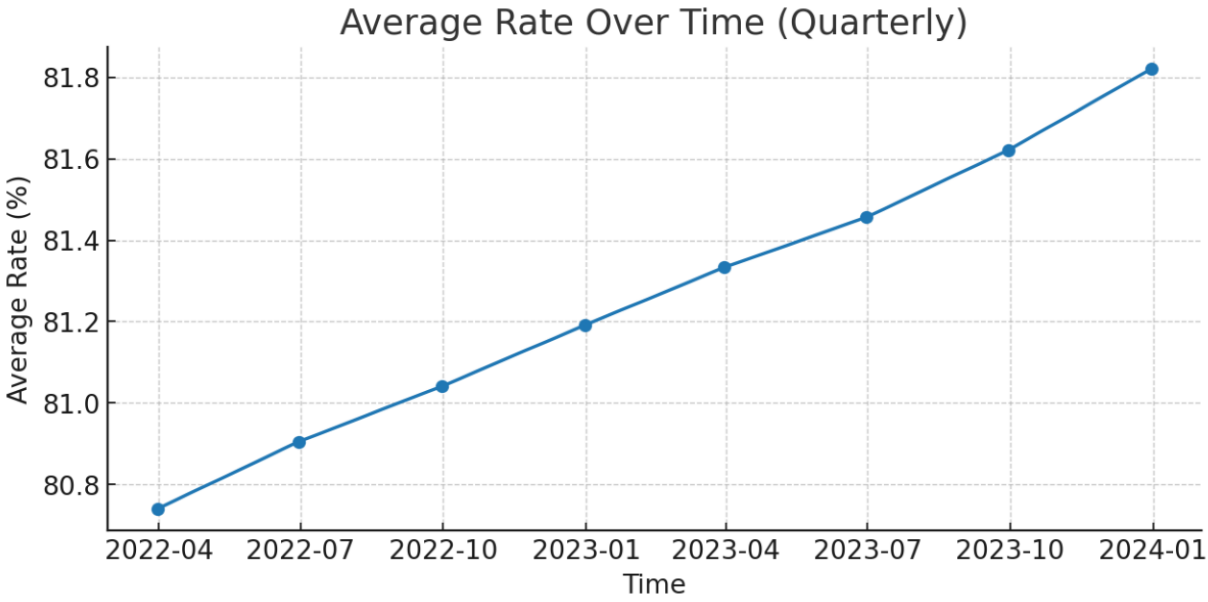

Figure 4 — Quarterly trend of the average rate.

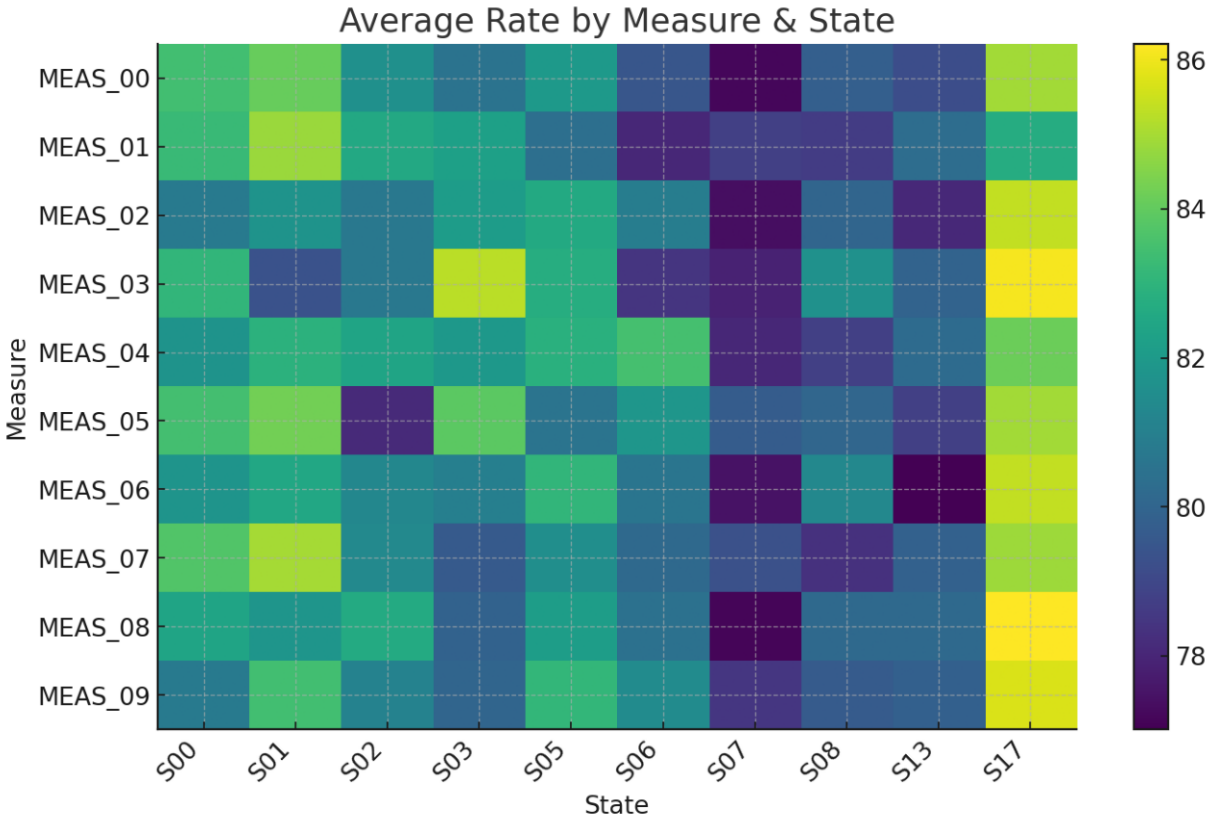

Figure 5 — Average rate by measure and state (10×10 subset).

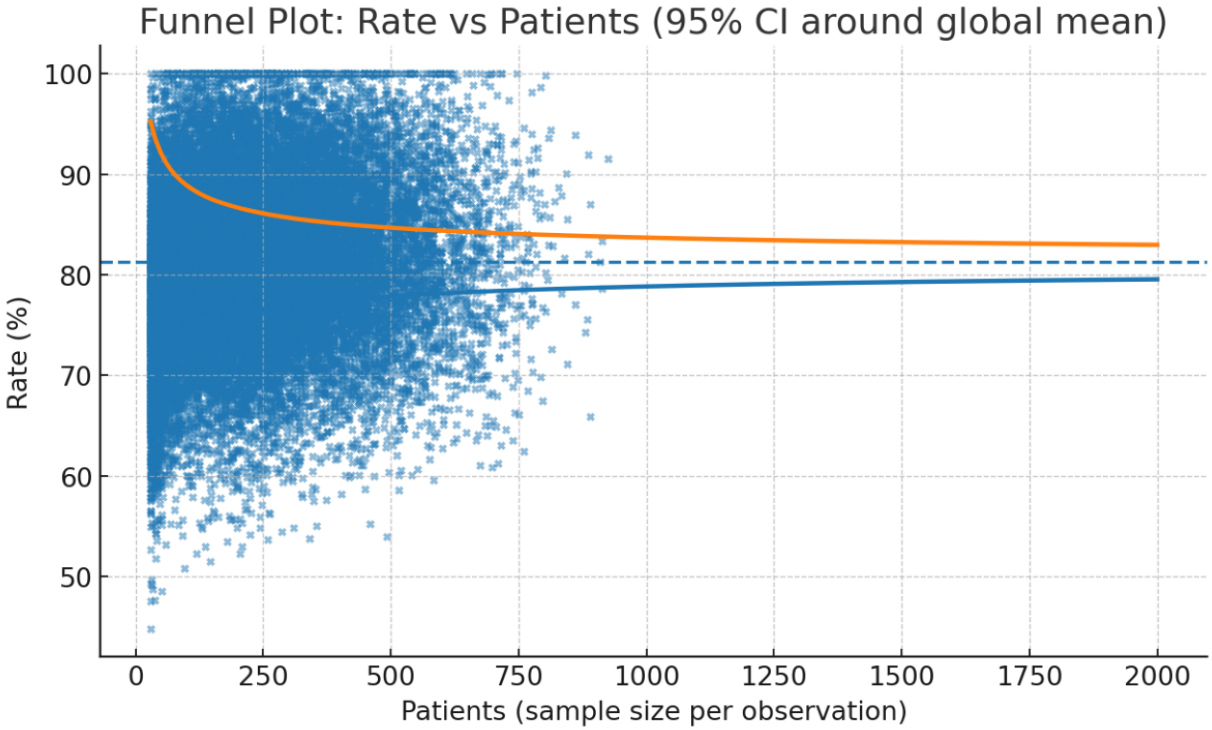

Figure 6 — Funnel plot: rate vs patients with 95% CI bands.

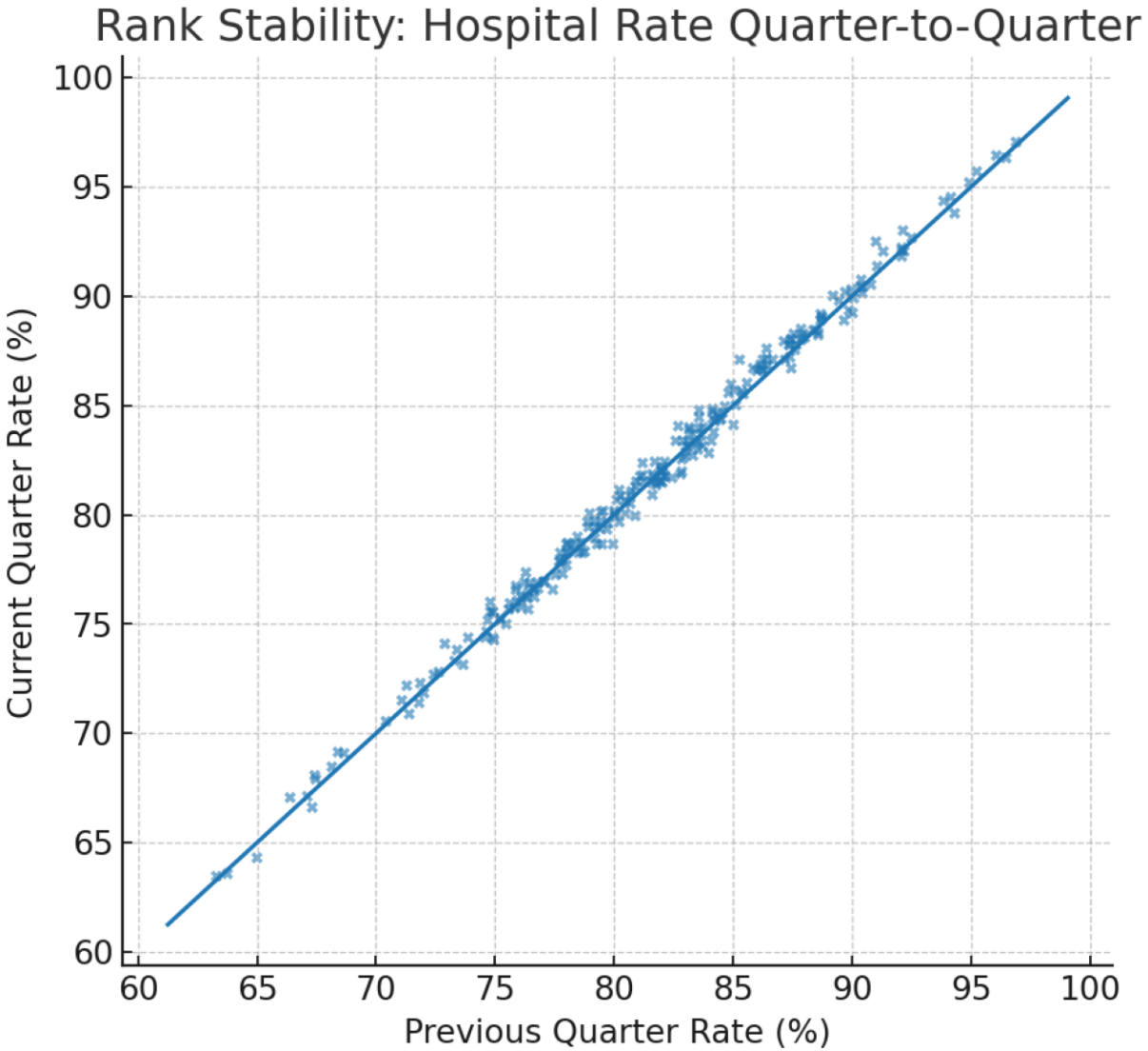

Figure 7 — Rank stability between consecutive quarters.

Key Insights

- Rates are moderately right-skewed with a fat tail of high performers.
- Clear geographic clustering suggests shared practices or resource levels.
- Quarter-to-quarter performance shows strong persistence—leaders tend to remain leaders.
- Funnel bands reveal several outliers that are unlikely due to sampling noise alone.

Limitations

- Real hospital data contains reporting lags and definitional changes across periods.
- Missingness is seldom random; sensitivity checks are essential.
- Composite scores depend on measure selection and standardization choices—document them.

Swap in your real CSV to reproduce with actual numbers.