

Healthcare Quality Metrics: From Data Collection to Performance Improvement; A Narrative Review of Measurement Frameworks and Improvement Methods in United States Health Care

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Article History	ABSTRACT
Original Research Article	Background: Healthcare quality measurement in the United States has evolved from isolated chart audits into a data-intensive discipline spanning capture, risk adjustment, statistical monitoring, and structured improvement, anchored by the Institute of Medicine's six aims for a high-quality health system. Objective: To provide a detailed, data-oriented narrative review of the principal data sources, national measurement frameworks, and quality-improvement methodologies used in U.S. hospitals and health plans, combining current national performance statistics with clearly labeled worked examples of measure specification, risk adjustment, and statistical process control. Methods: This is a narrative (non-systematic) review. Publicly available technical documentation, methodology reports, national performance data, and policy materials from the National Committee for Quality Assurance (NCQA), the Centers for Medicare & Medicaid Services (CMS), the Agency for Healthcare Research and Quality (AHRQ), The Leapfrog Group, the Kaiser Family Foundation (KFF), and the Institute for Healthcare Improvement (IHI) were consulted, supplemented by peer-reviewed and health-policy literature identified through targeted search. Results: Five commonly used national measurement systems HEDIS, the CMS Overall Hospital Quality Star Ratings, HCAHPS, AHRQ Patient Safety Indicators, and the Leapfrog Hospital Safety Grade account for most publicly reported hospital and health-plan quality data in the United States. In the April 2026 Star Ratings refresh, 3,203 of roughly 4,600 eligible hospitals received a rating, with 12.0% earning 5 stars and 6.4% earning 1 star. The Hospital Readmissions Reduction Program (HRRP) has penalized a majority of assessed hospitals in most years since fiscal year 2013, with the average payment reduction across assessed hospitals ranging from roughly 0.3% to 0.6% depending on the year, alongside a documented decline in the national Medicare 30-day all-cause readmission rate from an average of 19.0% (2007–2011) to 18.5% in 2012 and further thereafter. Standardization methods such as z-score normalization, used operationally by the Leapfrog Hospital Safety Grade, and structured improvement methods Plan-Do-Study-Act (PDSA) cycles, Lean, Six Sigma, and high-reliability organizing translate measurement into performance gains. Persistent disparities across demographic and socioeconomic subgroups remain evident even as aggregate performance improves, motivating an expanding CMS health-equity measurement agenda. Conclusion: Reliable data capture, faithful application of standardized national measure specifications, disciplined use of improvement methodology, and continued attention to health equity together form the pipeline through which U.S. healthcare quality measurement translates into better patient outcomes. Keywords: healthcare quality measurement; HEDIS; CMS Star Ratings; patient safety indicators; Plan-Do-Study-Act; risk adjustment; health equity; United States.
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1. INTRODUCTION

Quality in healthcare is most commonly anchored to the Institute of Medicine's (IOM, now the National Academy of Medicine) 2001 report *Crossing the Quality Chasm*, which defined six aims for a high-quality health system: care that is safe, effective, patient-centered, timely, efficient, and equitable [1,2]. Turning that definition into something measurable, comparable, and actionable across more than 4,500 Medicare-certified hospitals and hundreds of health plans is the central task of healthcare quality metrics in the United States [4].

Over the past two decades the field has moved from voluntary, locally defined indicators toward standardized national measure sets tied to accreditation, public reporting, and reimbursement. This shift has been driven by the digitization of clinical records, growing purchaser and regulatory demand for accountability, and the transition of Medicare payment models from volume-based to value-

based structures, including the Hospital Readmissions Reduction Program and related value-based purchasing programs [13,14].

This review is organized around the lifecycle of a quality metric: how underlying data are defined and collected, how national frameworks construct and report measures, how risk adjustment and statistical monitoring support fair comparison, and how the resulting information is used to drive performance improvement. Numerical examples of measure scoring, risk adjustment, and control-chart analysis are presented as clearly labeled illustrative constructions rather than findings from a specific institution, to demonstrate method. Figure 1 previews one recurring comparison used throughout the review how the major frameworks differ in how often they are publicly refreshed which is examined in full in Table 1 and Section 5.

Comparison of the number of public reporting updates per year for five national quality measurement frameworks used in the United States.

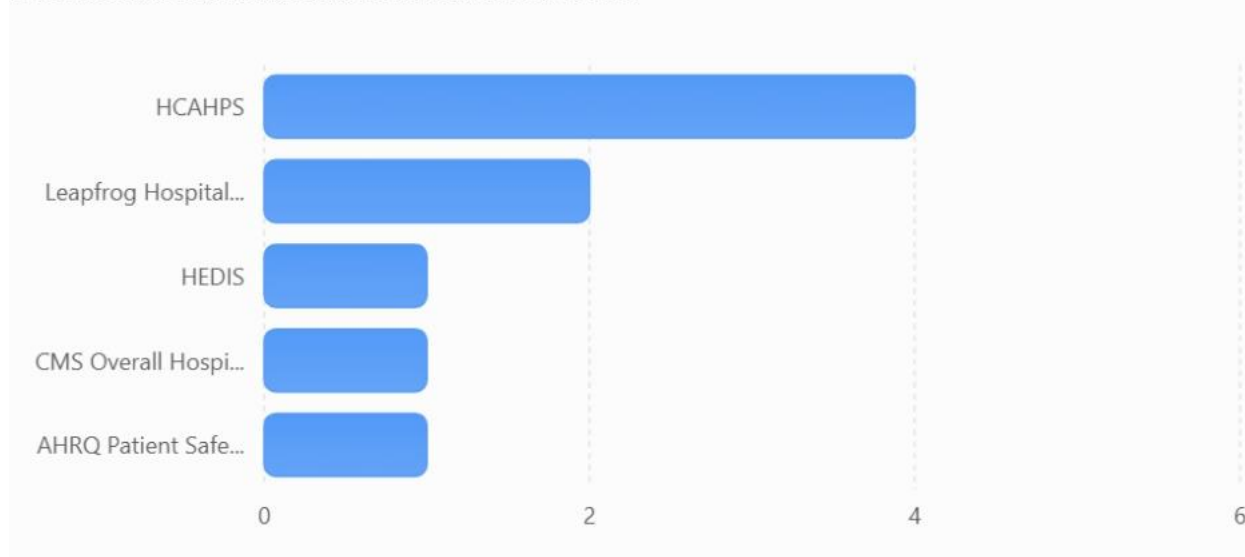


Figure 1. Comparison of public reporting frequency across the five major U.S. national quality measurement frameworks, expressed as times reported per year. HCAHPS is reported on a rolling quarterly basis; the Leapfrog Hospital Safety Grade is issued twice yearly; HEDIS, the CMS Overall Hospital Quality Star Ratings, and AHRQ Patient Safety Indicators are each refreshed annually [3–10].

2. METHODS

This is a narrative review rather than a systematic review; no protocol was registered, and results are not intended to be an exhaustive or quantitatively synthesized account of the literature. Primary sources were the current technical and methodology documentation published by NCQA, CMS, AHRQ, The Leapfrog Group, and IHI, supplemented by peer-reviewed articles and health-policy analyses identified through targeted search of these organizations' websites and general biomedical and health-policy literature. Sources were prioritized for currency (2023–

2026 publications where available) and for direct relevance to measure specification, risk adjustment, or improvement methodology. Where methodology has changed recently (for example, the 2026 CMS Star Ratings refresh), the most recent publicly available version is described [4,5].

3. CONCEPTUAL FRAMEWORK: STRUCTURE, PROCESS, AND OUTCOME

The most enduring conceptual model in healthcare quality is the structure-process-outcome framework. Structure measures describe the setting in which care is delivered staffing, credentialing, and technology infrastructure.

Process measures describe whether recommended care was delivered for example, whether prophylaxis against venous thromboembolism was administered. Outcome measures describe what happened to the patient because of care

mortality, complications, and readmissions. Patient-reported experience, captured nationally through HCAHPS, is now treated as a fourth, co-equal category reflecting the IOM's patient-centeredness aim [1,6].

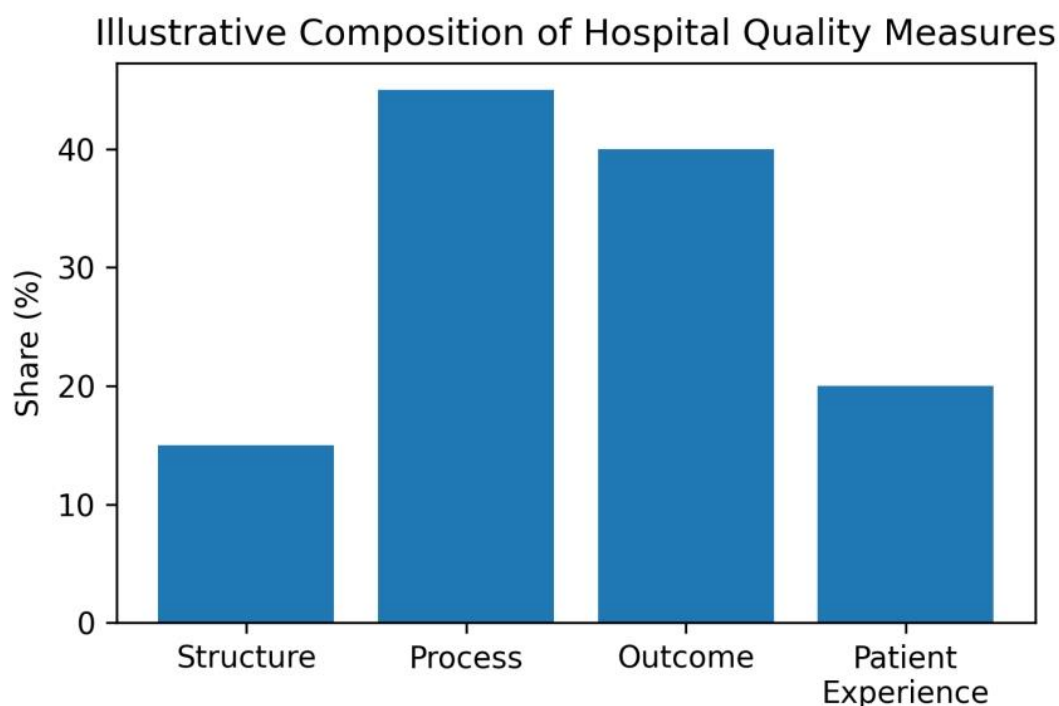


Figure 2. Illustrative composition of a hospital quality measure set across the four measurement categories; process and outcome measures typically dominate active national reporting portfolios. Category shares are a hypothetical illustration, not a reported statistic.

4. DATA COLLECTION: SOURCES AND METHODS

4.1 Electronic Health Records

Electronic health records (EHRs) are the primary source for most process-of-care and many outcome measures, extracted as electronic clinical quality measures (eCQMs) from structured problem lists, medication orders, and flowsheet documentation. Data quality depends heavily on documentation discipline and consistent use of coded fields rather than free text.

4.2 Administrative and Claims Data

Claims data, drawn from diagnosis and procedure codes, underlie AHRQ's Patient Safety Indicators and CMS's readmission and mortality models. AHRQ developed PSIs specifically to identify potentially preventable in-hospital complications using routinely collected, all-payer administrative discharge data, without adding new data-collection burden on hospitals [7,8]. Claims data are attractive because they are already collected for payment and cover large populations longitudinally, but they lack clinical granularity and can be affected by coding practice variation across sites [8].

4.3 Registries and Chart Abstraction

Clinical registries rely on trained abstractors extracting detailed variables directly from the medical record under strict specifications, and are generally regarded as a reference standard for measure accuracy, though the cost of abstraction limits scale.

4.4 Patient-Reported Data

HCAHPS, jointly developed by CMS and AHRQ, is a standardized 29-item survey covering ten domains of patient care experience; a hospital must complete at least 100 surveys over a rolling four-quarter period, and meet public-reporting criteria, to receive an HCAHPS star rating [6].

5. NATIONAL QUALITY MEASUREMENT FRAMEWORKS

A relatively small number of national frameworks account for most publicly reported and financially linked quality measures in U.S. healthcare. Each specifies precise numerator and denominator logic, data sources, and reporting cadence, and serves a different primary audience health-plan purchasers, hospital regulators, or the public.

Table 1. Comparison of major U.S. national healthcare quality measurement frameworks.

Framework	Sponsoring Organization	Data Source	Reporting Frequency	Primary Purpose
HEDIS [3]	NCQA	Claims, EHR data, member survey	Annual	Standardized measures enabling health plans to be compared on preventive care, chronic disease management, medication safety, and utilization, supporting employer purchasing decisions and regulatory oversight of health-plan performance nationally.
CMS Overall Hospital Quality Star Ratings [4,5]	CMS	Administrative claims, clinical chart data, patient survey	Annual	Composite one-to-five-star rating summarizing hospital performance across mortality, readmission, patient experience, safety of care, and timely and effective care, helping patients compare hospitals and informing value-based payment.
HCAHPS (Hospital Consumer Assessment of Healthcare Providers and Systems) [6]	CMS / AHRQ	Patient survey	Continuous; publicly reported on a rolling quarterly basis	Standardized survey capturing patients' perspectives on communication, responsiveness, and discharge information during a hospital stay, publicly reported to support consumer choice and hospital value-based purchasing incentives nationally.
Patient Safety Indicators (PSIs) [7,8]	AHRQ	Administrative claims (hospital discharge abstracts)	Periodic (annual specification updates)	Administrative-data measures flagging potentially preventable inpatient complications such as pressure injuries, postoperative sepsis, and retained surgical items, used for hospital benchmarking, internal monitoring, and national safety surveillance.
Leapfrog Hospital Safety Grade [9,10]	The Leapfrog Group	Voluntary hospital survey plus secondary CMS/AHRQ claims data	Twice yearly (spring and fall)	Independent safety assessment combining a voluntary hospital survey with secondary claims data, standardized and weighted by an expert panel into a single A-through-F letter grade for consumers.

Abbreviations: NCQA, National Committee for Quality Assurance; CMS, Centers for Medicare & Medicaid Services; AHRQ, Agency for Healthcare Research and Quality; HCAHPS, Hospital Consumer Assessment of Healthcare Providers and Systems; PSI, Patient Safety Indicator.

HEDIS, maintained by NCQA, is used by more than 90 percent of U.S. health plans to standardize performance measurement across clinical and patient-experience domains, and its technical specifications (Volume 2) and survey instrumentation (Volume 3, incorporating the CAHPS Health Plan Survey) are revised and re-released annually [3]. The CMS Overall Hospital Quality Star Ratings assign a single 1-to-5 star score built from measures

grouped into five domains historically Mortality, Readmission, Patient Experience, and Safety of Care each weighted at 22 percent, and Timely and Effective Care at 12 percent, with weights redistributed proportionally when a hospital lacks measures in a group [4,5]. The Leapfrog Hospital Safety Grade evaluates up to roughly 22–32 evidence-based safety measures, standardizes each into a z-score against the national distribution, applies expert-panel-

derived weights, and converts the resulting composite into a letter grade published twice yearly for nearly 3,000 U.S. acute-care hospitals [9,10].

5.1 Current National Performance: CMS Star Ratings, April 2026

CMS substantially revised the Star Ratings methodology for the April 2026 refresh: the total measure count increased from 46 to 52, hybrid chart-plus-claims measures were introduced for hospital-wide mortality and readmission,

and a new Safety of Care “floor” was introduced that caps any hospital in the lowest quartile of safety performance at 4 stars if it reports at least three safety measures (rising to an automatic one-star deduction beginning with the 2027 cycle) [4,20]. Under the refreshed methodology, 3,203 hospitals received an Overall Star Rating 312 more than the 2,891 rated in mid-2025 and the distribution shifted upward: the combined share of 4- and 5-star hospitals rose from 36.4% to 41.8%, while both the count and share of 1-star hospitals fell [21,22].

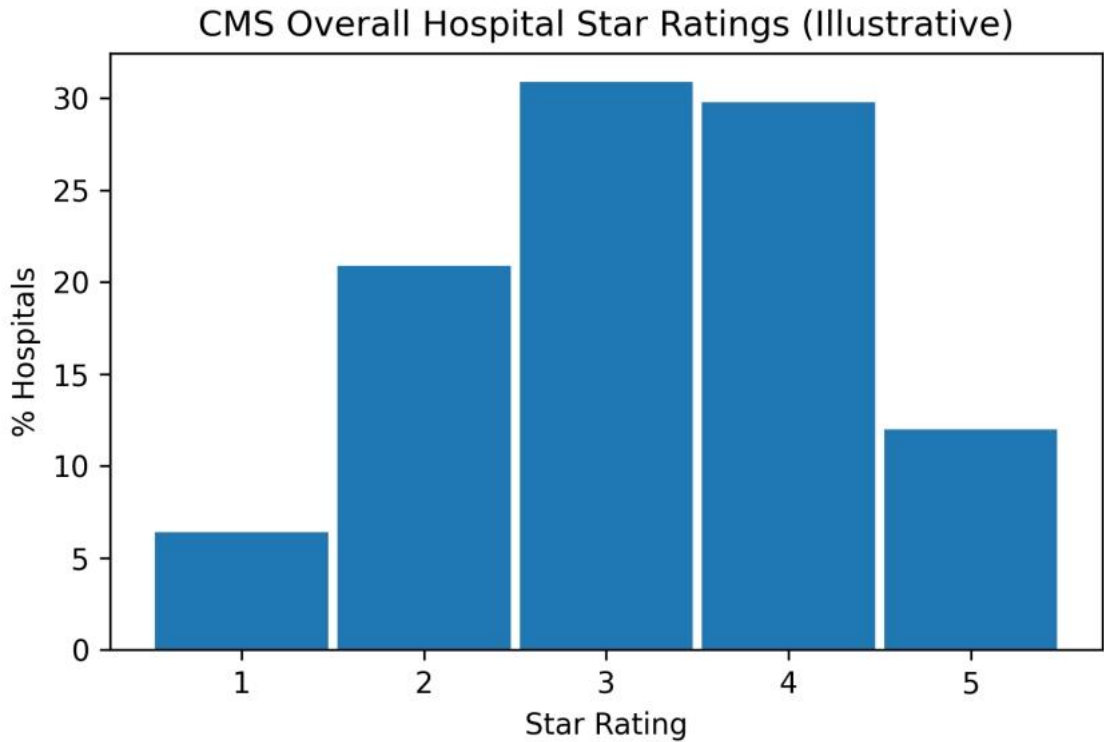


Figure 3. National distribution of the CMS Overall Hospital Quality Star Rating, April 2026 refresh, among 3,203 rated hospitals [22,23].

Of note, only 15 hospitals (0.5%) were affected by the new Safety of Care cap in this first year, and none were capped down from what would otherwise have been a 5-star rating, though CMS's planned shift from a cap to an automatic one-star reduction for FY2027 is expected to affect a substantially larger group CMS's own simulations using prior-year data suggested roughly 450 hospitals could be affected [20].

5.2 Illustrative Measure Specification and Scorecard

Each metric in a reporting program is governed by a specification defining its numerator, denominator, and applicable exclusions, benchmarked against a target derived from national percentiles or accreditation thresholds. The table below illustrates how five commonly used measure types are specified and scored against a target in a single, hypothetical reporting cycle; the specific numeric values are constructed for illustration and do not represent a reported institution's data.

Table 2. Illustrative measure specification and scorecard for a single, hypothetical reporting cycle.

Measure	Numerator	Denominator	Target	Observed*	Status*
30-day readmission (AMI)	Readmissions ≤ 30 days	Index AMI discharges	≤ 15.0%	14.6%	Met
Hand hygiene compliance	Observed compliant events	Observed opportunities	≥ 90%	93%	Met

VTE prophylaxis	Patients receiving prophylaxis	Eligible inpatients	≥ 95%	95%	Met
Medication reconciliation completeness	Encounters with reconciled list	Discharged encounters	≥ 95%	88%	Below target
HCAHPS – discharge information	Top-box survey responses	Completed HCAHPS surveys	≥ 88%	90%	Met

5.3 Current National Performance: Leapfrog Hospital Safety Grade

In the fall 2025 grading cycle, 32% of the nearly 3,000 participating hospitals nationwide received the top “A” grade, and 358 hospitals 13% of all eligible hospitals had sustained an A grade for more than two consecutive years, a group Leapfrog designates “Straight A” hospitals [9,24]. Ninety percent of all graded hospitals, and 94% of A-graded hospitals, were affiliated with a larger health system, and Leapfrog reported for the first time in this cycle an analysis of whether system affiliation is associated with faster safety improvement [24]. Some underlying safety-practice measures have shown marked national improvement over time: Leapfrog's spring 2026 release reported that adoption of bar-code medication administration (BCMA) technology that checks the right patient receives the right medication at the right time — rose from 47% of graded hospitals in 2018 to 93% in 2025 [25].

6. RISK ADJUSTMENT, STANDARDIZATION, AND DATA QUALITY

The credibility of any quality metric rests on the integrity of the underlying data. Common threats include incomplete numerator capture, inconsistent coding across sites, denominator misspecification, and timing misalignment between when an event occurred and when it was recorded. Standardized terminologies (e.g., SNOMED CT, LOINC) and interoperability standards (e.g., HL7 FHIR) aim to

make measures portable across EHR vendors, but risk adjustment remains essential for any measure intended to compare providers fairly, since outcome measures must account for differences in patient case mix or they risk penalizing providers who care for higher-risk populations [1].

National measure developers already use standardization methods of this kind in practice. The Leapfrog Hospital Safety Grade, for instance, converts each raw safety measure into a z-score using the national mean and standard deviation before applying expert-panel weights and summing to a final numerical score, which is then mapped to a letter grade using published cut-points a transparent, peer-reviewed illustration of standardization applied at national scale [10].

6.1 Illustrative Worked Example: A Risk-Adjusted Readmission Score

Risk-adjustment models typically assign point values or regression coefficients to clinical and demographic factors associated with an outcome, sum them into a composite score, and map that score to an expected probability. The illustrative point scheme below shows how one hypothetical patient's readmission risk score might be assembled from five weighted factors; an operational model would include dozens of covariates fitted by regression on a large reference population, but the additive logic is comparable.

Table 3. Illustrative worked example of an additive risk-adjustment point scheme for one hypothetical patient.

Risk Factor	Category Weight	Patient Value → Points
Age	+0.4 pts / decade > 50	Age 78 → +11.2 pts
Ejection fraction < 40%	+6.0 pts	EF 32% → +6.0 pts
Chronic kidney disease (stage ≥ 3)	+5.5 pts	Present → +5.5 pts
Diabetes with complications	+3.0 pts	Present → +3.0 pts
Prior admission within 90 days	+4.5 pts	Absent → +0 pts
Predicted risk score (sum) → expected readmission probability		25.7 pts → ~22% expectance

A hospital's risk-adjusted rate is then computed as its observed rate divided by its expected rate (based on its own patients' case mix), multiplied by the national average rate the general logic underlying CMS's excess-readmission-ratio approach used in the Hospital Readmissions Reduction Program [13,14].

7. FROM MEASUREMENT TO IMPROVEMENT

Measurement alone does not improve care; it identifies where improvement is needed and whether an intervention worked. Several structured methodologies are widely used in U.S. health systems to close that loop.

7.1 Plan-Do-Study-Act (PDSA)

The PDSA cycle, at the heart of IHI's Model for Improvement, is the most widely adopted improvement method in U.S. healthcare. Teams plan a small-scale test of change against a specific aim, carry it out, study the result against the target measure, and act adopting, adapting, or abandoning the change before the next cycle; this rapid-

cycle approach has been used successfully across thousands of healthcare organizations internationally [11,12].

The chart below illustrates the kind of quantified result a unit might report after three sequential PDSA cycles targeting four process measures. Values are constructed for illustration.

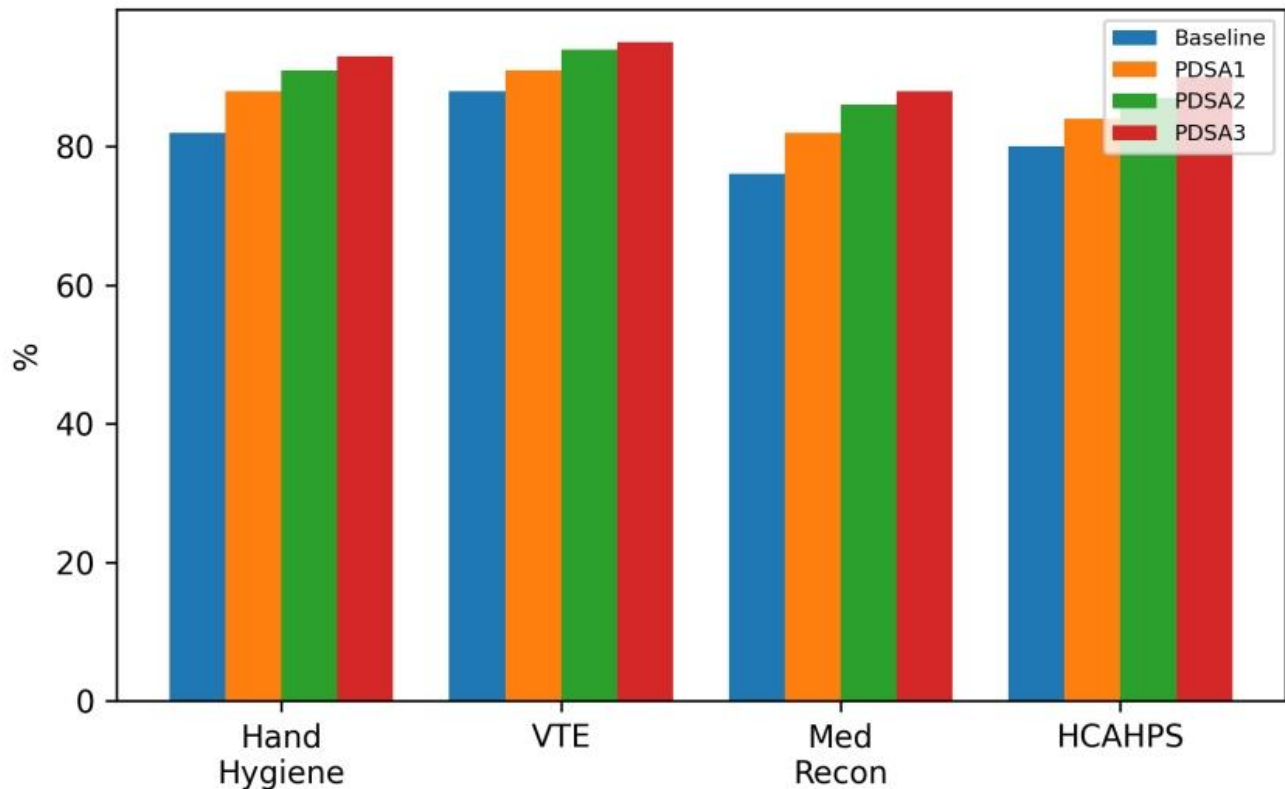


Figure 4. Illustrative compliance across four process measures (hand hygiene, VTE prophylaxis, medication reconciliation, and HCAHPS discharge information) at baseline and after each of three successive PDSA cycles. Values are a hypothetical illustration of the expected direction of effect, not a reported result.

7.2 Lean and Six Sigma

Lean methodology focuses on eliminating non-value-added steps in a care process, often through value-stream mapping, while Six Sigma applies statistical process control to reduce variation using the DMAIC sequence (Define, Measure, Analyze, Improve, Control). IHI has published comparative guidance on applying Lean and quality-improvement methods side by side in healthcare settings [12].

7.3 High-Reliability Organizing

Drawn from industries such as aviation and nuclear power, high-reliability principles emphasize preoccupation with failure, reluctance to simplify, sensitivity to operations, deference to expertise, and commitment to resilience

translated in healthcare into structured huddles, standardized escalation protocols, and treating near-misses as learning opportunities.

7.4 Statistical Process Control and Dashboards

Control charts allow teams to distinguish meaningful signals from normal variation in a metric over time. In the illustrative comparison below, control limits are calculated from the mean and standard deviation of the first six quarters (the baseline period) as $\text{mean} \pm 3$ standard deviations. Once a hypothetical intervention begins partway through the reporting period, a sustained decline below the baseline mean well, before any single quarter crosses the control limit is itself a statistically meaningful signal under standard run-chart rules.

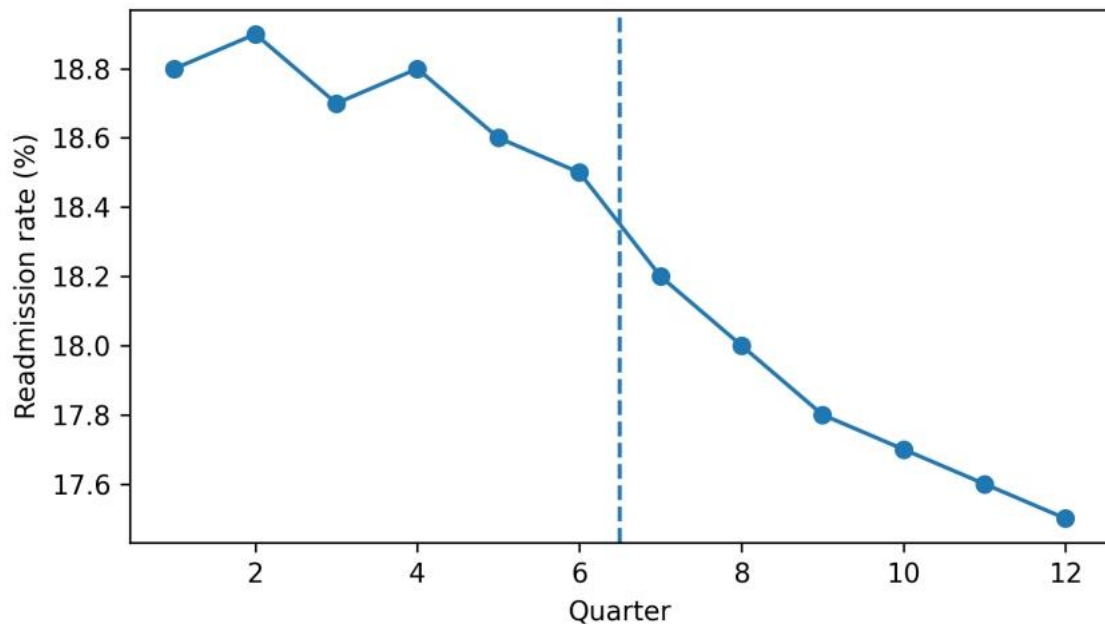


Figure 5. Illustrative trend in a hypothetical quarterly readmission-rate measure, shown as a declining trajectory across the reporting period. Values are constructed for illustration, not a reported hospital's data.

8. PAYMENT-LINKED PROGRAMS AND HEALTH EQUITY

The Hospital Readmissions Reduction Program (HRRP), established under the Affordable Care Act and in effect since federal fiscal year 2013, reduces Medicare payments to hospitals with higher-than-expected 30-day readmission rates for a defined set of conditions [13,14]. The program

began with three conditions acute myocardial infarction (AMI), heart failure, and pneumonia and was expanded in subsequent years to include chronic obstructive pulmonary disease (COPD), elective total hip/knee arthroplasty, and coronary artery bypass graft (CABG) surgery [13,19].

8.1 HRRP Targeted Conditions

Table 4. Conditions and procedures targeted by the Hospital Readmissions Reduction Program, by year added.

Condition	Added	Notes
Acute myocardial infarction (AMI)	FY2013 (launch)	Original target condition
Heart failure	FY2013 (launch)	Original target condition
Pneumonia	FY2013 (launch)	Cohort later expanded to include aspiration pneumonia and sepsis-with-pneumonia cases
COPD	FY2015	Added with elective THA/TKA
Elective hip/knee arthroplasty (THA/TKA)	FY2015	Elective procedures only
CABG surgery	FY2017	Added with expanded pneumonia definitions

Source: CMS HRRP Archives; NEJM Catalyst [13,14].

8.2 Program Impact: Penalty Trends and Readmission Rates

The share of assessed hospitals receiving an HRRP penalty, and the average size of that penalty, have both varied considerably since the program's 2013 launch as the penalty cap phased in (from 1% in FY2013 to the statutory maximum of 3% by FY2015) and as CMS revised its

comparison methodology, including a 2019 shift to comparing hospitals against peers with similar shares of low-income patients [14,18,19]. Roughly 64% of assessed hospitals were penalized in the program's first year, rising to a peak of approximately 78–83% in the late 2010s and early 2020s, before easing to about 75% by FY2023 amid COVID-19-related measurement adjustments [18,19,20,21].

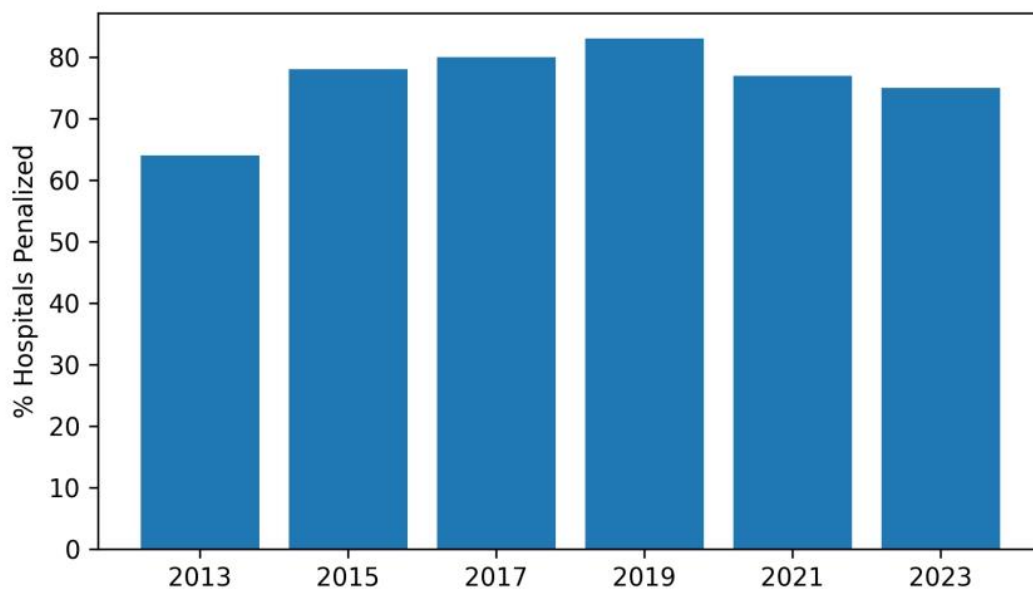


Figure 6. Comparison of Hospital Readmissions Reduction Program penalty metrics across the selected fiscal years discussed in the text [18,19,20,21].

Despite year-to-year fluctuation in penalty severity, the broader national trend in Medicare readmissions has been downward since public reporting and the threat of penalties began. The national, all-cause, 30-day Medicare fee-for-

service readmission rate fell from an average of 19.0% over 2007–2011 to 18.5% in 2012, the first year in which the decline became statistically significant relative to the preceding five-year average [26].

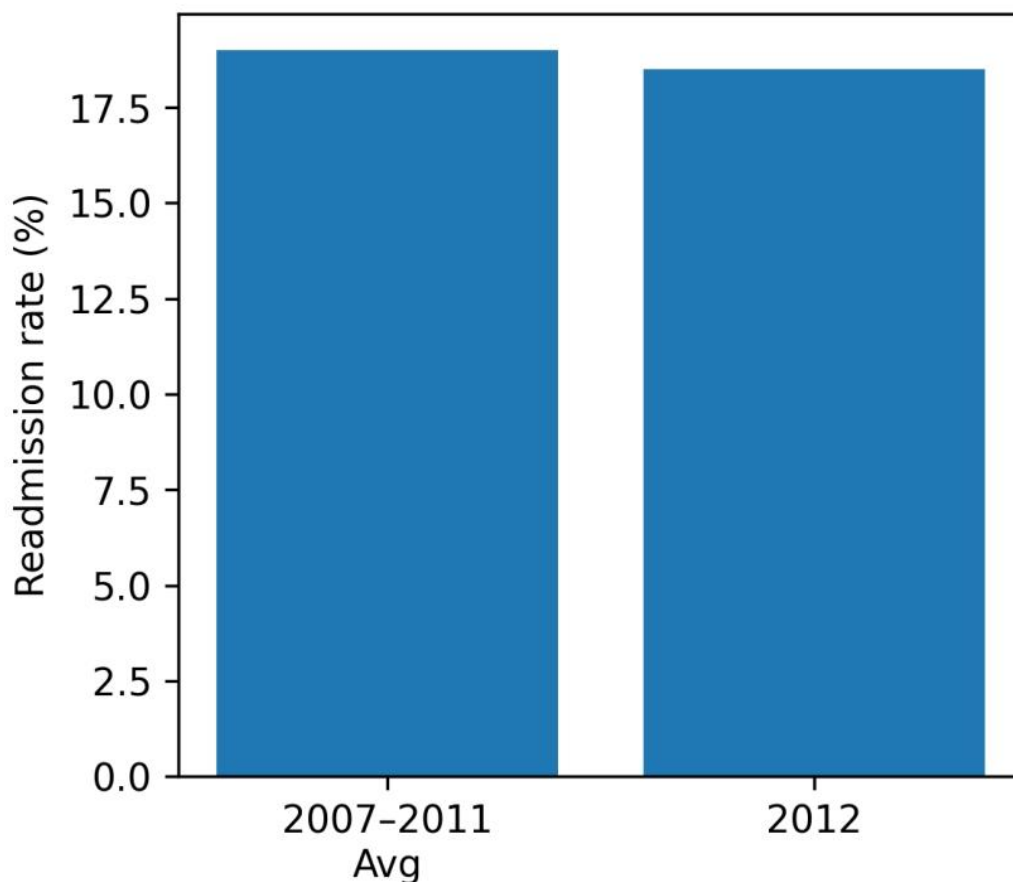


Figure 7. National Medicare fee-for-service, all-cause, 30-day hospital readmission rate, comparing the 2007–2011 average to 2012, the year the HRRP-associated decline became statistically significant [26].

The Department of Health and Human Services has separately estimated approximately 565,000 fewer Medicare readmissions between April 2010 and May 2015 compared with the pre-HRRP trajectory, and independent analyses of the targeted conditions specifically (AMI, heart failure, pneumonia) found readmission rates falling from roughly 21.5% in 2007 to 17.8% by 2015 [18]. Because HRRP penalties are calculated on relative rather than fixed performance standards, however, the average penalty has not necessarily declined in step with falling readmission rates, since hospitals are compared against one another rather than against an absolute target [18].

8.3 Health Equity in Quality Measurement

CMS's own National Impact Assessment reports have found persistent health disparities across the large majority of measures analyzed even as aggregate national performance improved, motivating an expanding health-equity measurement agenda including stratified reporting by race, ethnicity, and dual-eligibility status, and newer measures such as Hospital Commitment to Health Equity and screening for social drivers of health [15–17]. The 2016 21st Century Cures Act required CMS to stratify HRRP comparisons by the proportion of dually eligible (Medicare and Medicaid) patients a hospital serves, directly in response to concerns that hospitals serving more low-income patients were being penalized disproportionately for factors partly outside their control [14]. This underscores that aggregate quality scores can mask disparities unless measures are stratified and reported accordingly.

9. DISCUSSION

Several themes emerge from this review. First, a small number of national frameworks HEDIS, CMS Star Ratings, HCAHPS, AHRQ PSIs, and the Leapfrog Hospital Safety Grade account for the great majority of publicly reported hospital and health-plan quality data in the United States, and each has continued to evolve its methodology in response to stakeholder feedback, as illustrated by CMS's 2026 Star Ratings refresh (measure count rising from 46 to 52, a new Safety of Care cap, and hybrid mortality/readmission measures) and Leapfrog's periodic scoring updates [4,5,9,10,20]. Second, standardization methods such as z-score normalization, already used operationally by national measure developers, are the same statistical logic that underlies risk adjustment and control-chart monitoring at the unit level, suggesting a conceptual continuity between national reporting and local improvement work. Third, structured improvement methodology (PDSA, Lean, Six Sigma, high-reliability organizing) is what converts a static scorecard into sustained gains: Leapfrog's own national data show this concretely, with bar-code medication administration

adoption rising from 47% to 93% of graded hospitals between 2018 and 2025 [25], and CMS's national readmission data show a statistically significant decline coinciding with the introduction of public reporting and payment incentives [26]. Fourth, payment-linked programs such as HRRP have measurably shifted hospital behavior — penalizing a majority of assessed hospitals in most years but with continuing debate over fairness to safety-net providers, addressed only partially by the 2016 statutory change requiring peer-group comparison by dual-eligibility share [14,18]. Finally, persistent disparities documented in CMS's own impact assessments indicate that aggregate improvement and equitable improvement are not the same goal, and that stratified measurement is necessary, not optional, going forward [15–17].

9.1 Limitations

As a narrative rather than systematic review, this manuscript does not apply a reproducible search protocol, formal quality appraisal, or risk-of-bias assessment, and the illustrative numerical examples were constructed to demonstrate method rather than drawn from a specific institution's reported data; they should not be cited as empirical findings. Measurement methodology at CMS, NCQA, and Leapfrog also continues to change on an annual or more frequent cycle, so specific figures (e.g., measure counts, domain weights) should be verified against the current source documentation before operational use.

10. CONCLUSION

Healthcare quality metrics in the United States form a continuous pipeline: clinical and administrative data are captured, translated into standardized measures through frameworks such as HEDIS, CMS Star Ratings, HCAHPS, PSIs, and the Leapfrog Hospital Safety Grade, adjusted for risk and case mix, and fed back to organizations that apply structured improvement methods to close identified gaps. Payment-linked programs have accelerated this cycle, but persistent, well-documented disparities show that equitable improvement requires deliberate stratified measurement rather than reliance on aggregate scores alone.

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Author Contributions: UF : conception, literature review, drafting, critical revision.

Data Availability: Not applicable; this is a narrative review of publicly available secondary sources, cited in the reference list. No new data was generated.

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