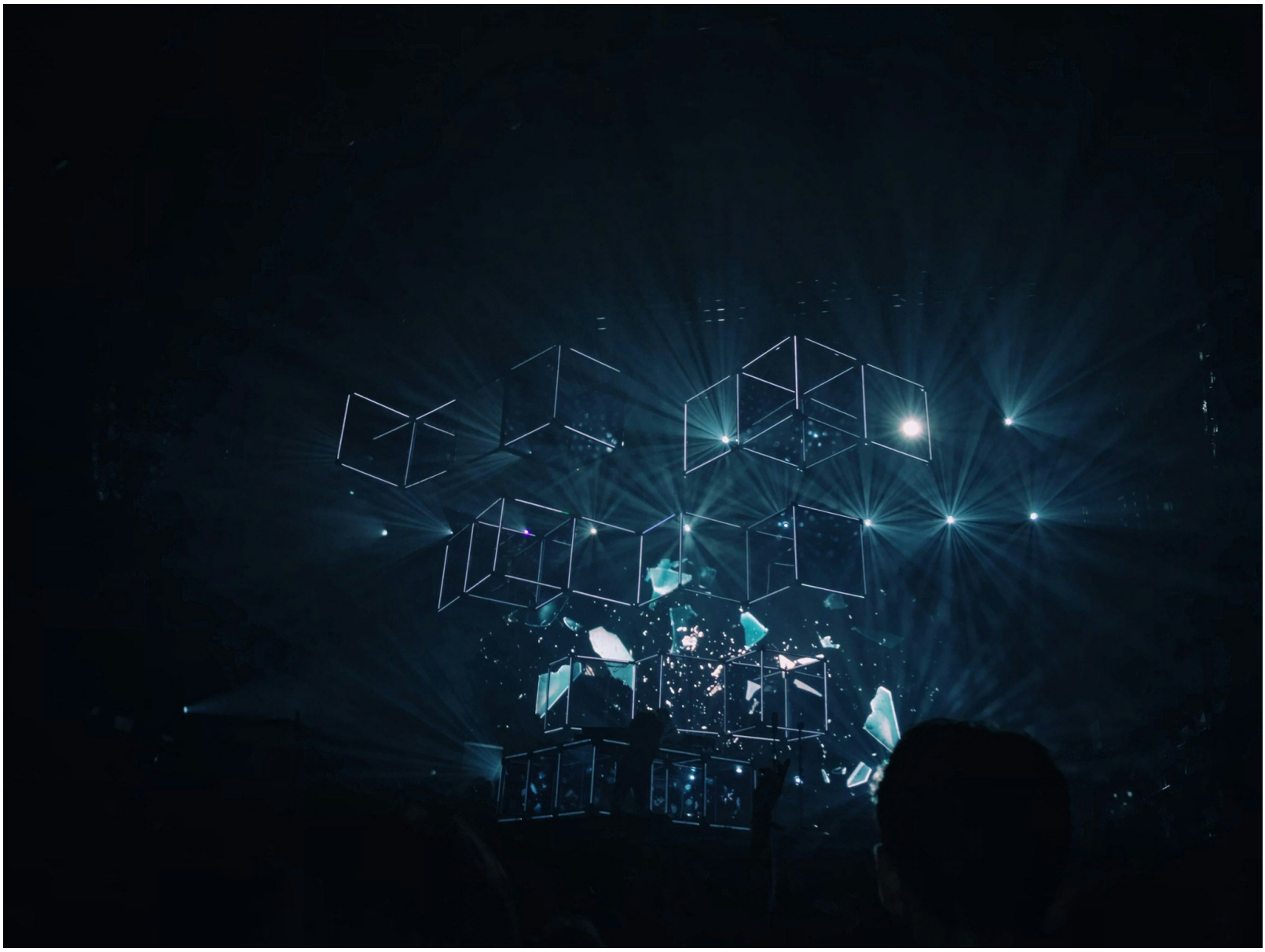

Benchmarking Low Volume / High Risk Elective Surgery Procedures to Improve Surgical Outcomes and Improve Readiness Using Machine-Learning Algorithms

Theo Squires

Research Assistant

MIT Mission Innovation X

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Executive Summary

This report explores the context of benchmarking in US healthcare and the incentives for quality improvement, largely from the perspective of financial incentives provided by the Centers for Medicare and Medicaid (CMS), to analyze which fields of medicine are likely most suitable for AI-based benchmarking methodologies, as deployed by Alexandria Health. The report focuses on fields of medicine that have an existing national registry with some form of risk adjustment, identifying eight that meet this criteria. It then calculates a financial value at stake for quality improvement in each of these fields as a proxy for which medical fields may have the greatest incentives to improve their benchmarking methodologies. Based on this analysis, the report found that surgical fields are most likely to be suited to an AI-based approach to benchmarking. Specifically, AI-based benchmarking approaches are likely to be most successful in cardiology and vascular surgery; general, trauma and acute-care surgery; ophthalmology; and orthopedic surgery. Individual hospitals that are underperforming in quality of outcomes can be identified using publicly available CMS data and may be good targets for deploying AI-based benchmarking.

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Introduction

MIT was tasked with evaluating Alexandria Health's TrueHQ AI-powered benchmarking tool in trauma and acute care surgery (Phase 1) and then researching which fields of medicine are best suited to applying AI-based benchmarking tools, such as that developed by Alexandria Health (Phase 2). The results of Phase 1 (evaluating TrueHQ) are published separately; this report will focus on identifying which fields of medicine would be best suited to AI-based benchmarking tools. First, the report will consider the context of benchmarking in healthcare and the existing incentives for quality improvement, followed by generating a rubric to assess the suitability of Alexandria Health's approach to different fields of medicine, followed by recommendations.

Context

Benchmarking in Healthcare

Benchmarking is one of the first steps in healthcare quality improvement: as the management expression goes, if you cannot measure it, you cannot manage it[1]. Sometimes, however, hospitals struggle to generate actionable insights from benchmarking. Hospitals may have heterogeneous outcomes because of different underlying risk factors among their patient population, for example. This can also change year-to-year, making longitudinal analysis difficult. Without a risk-adjusted approach, benchmarks are less effective at showing which hospitals are underperforming due to quality issues, vice having subpar outcomes due to a systematically sicker patient population. In theory, the more accurate this risk adjustment is, the more insightful should be the benchmarking results[2].

One of the basic ingredients of any benchmarking is the dataset tracking patient histories, procedures and outcomes. Currently, this is largely tracked through medical registries, which are usually focused on a specific condition or medical specialty[3]. These registries are usually maintained by a medical society, such as the American College of Surgeons, or American Academy of Ophthalmology, which collect information from their members and then provide insights in exchange. However, most of these registries are not risk adjusted and therefore are of limited value for benchmarking outcomes across hospitals or healthcare providers.

One major existing provider of risk-adjusted benchmarking is the National Surgical Quality Improvement Program (NSQIP), which analyzes data from over 700 hospitals to identify patterns in surgical outcomes. NSQIP collects data on various patient and surgical characteristics, such as patient age and medical history, to attempt to risk-adjust its benchmarking and thus make the analysis more comparable across hospitals which have different

[1] Willmington C, Belardi P, "The contribution of benchmarking to quality improvement in healthcare. A systematic literature review.", BMC Health Services Research, 02 Feb 2022

[2] Parikh C, "The Power of AI Technology in Risk Adjustment Coding for Healthcare", The Healthcare Guys, 23 Aug 2022

[3] National Institutes of Health, "NIH Clinical Research Trials and You: List of Registries", nih.gov, 02 May 2023

patient populations[4]. Using this data, NSQIP can identify hospitals with a risk-adjusted over-occurrence of certain events such as infections, bleeding, and readmissions. NSQIP provides this analysis back to participating hospitals in quarterly reports which scorecard their performance. By pinpointing where hospitals are underperforming, the quality improvement processes in those hospitals should be able to better target their efforts.

Benchmarking under the status quo has several issues, however. Briefly, these are:

1. Bias and confounding factors: NSQIP currently uses machine learning methods to risk-adjust its analysis. However, machine learning algorithms can be affected by bias and confounding factors, such as differences in reporting, patient population or surgical practices between hospitals. These factors could lead to inaccurate risk adjustment and therefore inaccurate conclusions, making it difficult for hospitals to derive actionable insights from the process.
2. Interpretability: Machine learning models can be complex and difficult to interpret, making it challenging for healthcare providers to understand and act on the insights generated by the analysis. NSQIP reports to hospitals do not currently provide transparency into their risk adjustment methodology.
3. Data quality, timeliness and completeness: Machine learning methods rely on large amounts of high-quality, timely and complete data to make accurate predictions and identify patterns. NSQIP draws data from more than 700 hospitals, giving a large dataset. However, there is often more than six months time latency in hospitals identifying through NSQIP benchmarking any trends.
4. Granularity. NSQIP reporting provides greater granularity than some other benchmarking, but may not be sufficiently granular to derive all actionable insights.

An improvement to the status quo would likely need to address one or more of these issues, or do it at lower cost.

Quality Incentives in Healthcare

There are two broad motivations for quality improvement in the US healthcare system: improving patient outcomes and reducing costs.

The first motivation is the desire to improve patient outcomes. For example, hospital-acquired conditions (the occurrence of which is an important measure of quality), such as Central Line-Associated Bloodstream Infections and sepsis, are associated with significant excess mortality. Aside from the obvious and important altruistic reasons for improving quality, improving patient outcomes also makes business sense, as providers with a better track record of patient outcomes can attract more business or even charge more money for their services.

The second motivation is to reduce costs. Healthcare is expensive and bad outcomes even more so. Healthcare providers often pay between $4,000 to $12,000 per year in malpractice insurance,

[4] Cohen ME, et al. “Optimizing ACS NSQIP modeling for evaluation of surgical quality and risk: patient risk adjustment, procedure mix adjustment, shrinkage adjustment, and surgical focus.” J Am Coll Surg. Aug 2013

while surgeons often pay $40,000 to $50,000[5]. Some hospital-acquired conditions are not reimbursed by Centers for Medicare and Medicaid Services (CMS) and cannot be on-charged to patients, meaning that the costs of additional treatment is borne by the providers directly[6].

CMS provides additional financial incentives through four main mechanisms:

Program	Summary of scope	Summary of value at stake
Hospital-Acquired Conditions (Present On Admission Indicator)[7]	Medicare Part A - Inpatient Prospective Payment System (IPPS) hospitals	Designated hospital-acquired conditions will not be reimbursed by CMS
Hospital-Acquired Conditions Reduction Program[8]	Medicare Part A - worst 25% of providers based on composite HAC score	Bottom quartile of hospitals have 1% reduction in total Medicare FFS payments
Merit-based Incentive Payment System[9]	Medicare Part B - all enrolled providers	Up to 9% bonus/malus on Medicare FFS payments
Medicare Advantage[10]	Medicare Part C - all enrolled providers	Patients do not receive more funding than their risk-adjusted amount indicates, incentivizing cost reductions and preventive medicine

Figure 1: Summary of CMS quality-based incentive programs

Some fields of healthcare are more susceptible to certain hospital-acquired conditions than others (eg, surgery more than optometry), so CMS quality incentives are not equally relevant to all providers. Thus, from a financial perspective, there is likely higher impetus to improve quality in some fields than others.

Hypothesis

Machine learning methods in benchmarking will be best suited to fields of medicine that exhibit the following characteristics:

1. Quality, timely and complete data to facilitate generating and maintaining a robust benchmarking model. In practice, this means a large, well-maintained and available national registry.

[5] Bravo Policy, "Malpractice Insurance Costs by Specialty (2023 Rates)", bravopolicy.com, 04 January 2023
[6] Stone P, "Changes in Medicare reimbursements for hospital-acquired conditions including infections", American Journal of Infection Control, Nov 2009
[7] Section 5001(c) of the Deficit Reduction Act (2005) Hospital-Acquired Conditions (Present on Admission Indicator) | CMS
[8] Section 1886(p) of the Social Security Act HACRP Overview | CMS
[9] CMS Merit-Based Incentive Payment SystemTraditional MIPS Overview | CMS
[10] Better Medicare Alliance, "Understanding Risk Adjustment in Medicare Advantage: White Paper", June 2017

2. Existing quality improvement infrastructure which can derive and action insights from the benchmarking tool.
3. Buy-in of key stakeholders.
4. High potential cost savings from improving quality.
5. High potential to improve patient outcomes.

Methodology

This analysis used the following methodology to determine where an AI-based risk-adjusted benchmarking would be most successful:

1. Identify medical societies in the US.
2. Identify which medical societies maintain registries.
3. Determine if the registry currently uses any form of risk adjustment.
4. Identify the value at stake tied to quality for different CMS programs.
5. Rank which fields of medicine are likely to be most amenable to AI-based benchmarking based on a combination of already having a registry and having higher value at stake.
6. Make recommendations based on these analyses.

Reason for focus on financial measures (value at stake)

This report focuses on financial value at stake as selling a benchmarking tool to hospital administrators (the likely customer) will likely depend, at least in part, on a financial argument. However, financial value is also likely a reasonable proxy for patient outcomes. For example, on average, the most expensive hospital-acquired condition to treat is a Central Line-Associated Bloodstream Infection (CLABSI), while the lowest cost hospital-acquired condition to treat is, on average, Obstetric Adverse Events (OBAE). CLABSI is, on average, 76 times more expensive to treat than OBAE, and has 30 times higher excess mortality rate[11].

Assessing customer demand

This analysis does not consider provider demand or stakeholder buy-in. Phase 1 of this project included stakeholder interviews for Alexandria Health's current product in trauma and acute-care surgery benchmarking. A similar interview process would be valuable to assess the receptivity of other fields of medicine to AI-based benchmarking products.

[11] Agency for Healthcare Research and Quality, "Estimating the Additional Inpatient Cost and Mortality Associated with Selected Hospital-Acquired Conditions", Nov 2017

US Medical Societies & Registries

This report identified 51 medical societies in the US, covering most or all disciplines of medicine. The full list is included in Appendix A.

Of these, 24 societies maintain, or are developing, a national registry, summarized below.

Society	Members	Registry Name
American Academy of Ophthalmology	32,000	IRIS
American College of Cardiology	54,000	NCDR
Society of Cardiovascular Magnetic Resonance	3,000	SCMR Registry
American College of Radiology	40,000	NRDR
American Society of Clinical Oncology	45,000	QOPI
American College of Surgeons	84,000	NSQIP
American Academy of Dermatology	20,500	DataDerm
American College of Emergency Physicians	38,000	CEDR
American Academy of Orthopaedic Surgeons	38,000	Multiple
North American Spine Society	8,800	Spine Registry
American College of Rheumatology	9,400	RISE
American Urological Association	22,000	AQUA
American Academy of Neurology	38,000	Axon
American Society for Gastrointestinal Endoscopy	15,000	GIQUIC
American Society for Clinical Pathology	130,000	NPQR
American Academy of Physical Medicine and Rehabilitation	8,000	AAPM&R Registry
American Society of Anesthesiologists	56,000	NACOR
American Psychiatric Association	37,800	PsychPRO
Society of Vascular Surgery	6,000	NCDR
Society of Interventional Radiology	8,000	VIRTEX
American Academy of Allergy, Asthma & Immunology	7,000	AAAAI QCDR
Society of Thoracic Surgeons	7,600	Multiple
American Society for Plastic Surgeons	11,000	Multiple
American Academy of Pediatrics	67,000	CHILD

Figure 2: List of US medical societies with registries

Of these 24 registries, six are currently risk-adjusted (primarily using logistic regression models) and a further two are currently exploring introducing risk adjustment.

Current risk adjustment was considered an important indicator of the registry having data in a format and sufficient quality that is amenable to AI-based risk adjustment. Alexandria Health's methodology requires that the registry have high quality information on both the patient, the procedure, and the outcome. For example, the American Academy of Neurology's Axon registry is not currently risk adjusted as the registry does not have sufficient fidelity on patient history or outcomes[12]. Alexandria Health's AI models are unlikely to provide much value in that situation if the prerequisite data is missing.

Therefore, this analysis focused on the six registries that are currently risk-adjusted and the two that are exploring risk-adjustment, summarized below.

Society responsible	Registry	Risk adjustment
American Academy of Ophthalmology	IRIS	Investigating[13]
American College of Cardiology	NCDR	Logistic regression[14]
American College of Radiology	NRDR	Investigating[15]
American College of Surgeons	NSQIP	Logistic regression[16]
American Academy of Orthopaedic Surgeons	Multiple	Yes: assumed logistic regression
American Psychiatric Association	PsychPRO	Yes: method unknown
Society of Vascular Surgery	NCDR	Logistic regression
American Academy of Allergy, Asthma & Immunology	AAAAI QCDR	Yes: method unknown
Society of Thoracic Surgeons	Multiple	Logistic regression[17]

Figure 3: List of US registries with risk-adjustment

[12] American Academy of Neurology, "Quality Measurement Manual: 2022 Update", aan.com, 2022

[13] Pershing S, Lum F. The American Academy of Ophthalmology IRIS Registry (Intelligent Research In Sight): current and future state of big data analytics. Curr Opin Ophthalmol. 2022 Sep 1;33(5):394-398

[14] Peterson ED, et al. "Contemporary mortality risk prediction for percutaneous coronary intervention: results from 588,398 procedures in the National Cardiovascular Data Registry." J Am Coll Cardiol. 2010 May 4;55(18):1923-32

[15] American College of Radiology, "Benchmarking Methodology", 04 Feb 2022

[16] Cohen M, et al. "Optimizing ACS NSQIP Modeling for Evaluation of Surgical Quality and Risk: Patient Risk Adjustment, Procedure Mix Adjustment, Shrinkage Adjustment, and Surgical Focus", Journal of the American College of Surgeons, Vol 217:2, 2013, 336-346

[17] Shahian, D, et al. "Quality Measurement in Cardiac Surgery." *Adult and Pediatric Cardiac Surgery. STS Cardiothoracic Surgery E-Book*, Chicago: Society of Thoracic Surgeons, 2023. *STS Surgery*, ebook.sts.org.

Value at stake of CMS quality-focused programs

Hospital-Acquired Conditions (Present on Admission Indicator)

The first CMS quality incentive program is HAC(POAI), which was introduced in Section 5001(c) of the Deficit Reduction Act (2005). HAC(POAI) defines a list of hospital-acquired conditions for which CMS will not reimburse the provider any additional costs incurred in their treatment.

HAC(POAI) applies to Medicare Part A Inpatient Prospective Payment Systems (IPPS) hospitals[18]. Most US hospitals are covered by IPPS, but there are nine exempt categories, including Critical Access Hospitals, Long-Term Care Hospitals, Cancer Hospitals, Children's Inpatient Facilities, Inpatient Psychiatric Hospitals, Inpatient Rehabilitation Hospitals and Veterans Administration/Department of Defense Hospitals.

HAC(POAI) targets conditions that are high in cost or high in volume, or both; result in the assignment of a case to a higher payment category; and could reasonably have been prevented through the application of evidence-based guidelines. Currently, there are 14 categories of hospital-acquired conditions defined by HAC(POAI), with each category corresponding to multiple ICD-10 codes.

Under HAC(POAI), the additional cost of an HAC (over the initial diagnosis present on admission) is borne by the provider. These costs can be very large and directly affect a hospital's bottom line. For this reason, HAC(POAI) likely provides the strongest financial incentives of any CMS quality-based incentive system for quality improvement.

The following table, largely derived from research by the Agency for Healthcare Research and Quality (AHRQ), gives estimated costs for each HAC event in 2023 dollars (updated using healthcare inflation data).

[18] CMS, "Affected Hospitals | HAC(POAI)", 01 Dec 2021

Hospital-Acquired Condition	Average additional cost per event[19] [20]
Central Line-Associated Bloodstream Infections	$62,000
Ventilator-Associated Pneumonia	$60,000
Sepsis	$46,000[21]
DVT / VTE	$33,000
Stroke	$24,000 - $40,000[22]
Surgical Site Infections	$30,000
C. Difficile Infections (CDI)	$22,000
Pressure Ulcers	$19,500
Catheter-Associated Urinary Tract Infection	$16,000
Falls	$9,000
Adverse Drug Event	$7,500
Obstetric Adverse Events (OBAE)	$800

Figure 4: Estimated additional cost of Hospital-Acquired Conditions

Of note, not all of these HACs are likely to arise in all disciplines of medicine. In fact, they skew towards surgery. The implication of this is that HAC(POAI) is likely a stronger incentive for quality improvement in surgery, and fields where HACs are likely to arise, than in other fields.

This cost data was then applied to estimates of HAC occurrence in the US, also derived from AHRQ reporting[23]. HAC occurrence rates are reported per 1,000 discharges and there were 31.4M discharges in 2022 from all non-federal, short-term general hospitals (of which there are approximately 5,000 in the US), of patients aged 18+[24]. Of these 5,000 hospitals, approximately 3,200 hospitals were enrolled in IPPS as of 2019 and thus covered by HAC(POAI)[25]. It is unknown if the rates of HAC events differ between IPPS and non-IPPS hospitals and what the exact breakdown of discharges between IPPS and non-IPPS hospitals is. The following analysis is therefore based on the full 31.4M discharges.

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[19] Agency for Healthcare Research and Quality, "Estimating the Additional Inpatient Cost and Mortality Associated with Selected Hospital-Acquired Conditions", Nov 2017

[20] US Bureau of Labor Statistics, "Medical case in US city average, all urban consumers, not seasonally adjusted", April 2023

[21] Paoli C, "Epidemiology and Costs of Sepsis in the United States—An Analysis Based on Timing of Diagnosis and Severity Level", Critical Care Medicine, Dec 2018

[22] Wang G, "Costs of hospitalization for stroke patients aged 18-64 years in the United States", Journal of Stroke and Cerebrovascular Diseases, May 2014

[23] Agency for Healthcare Research and Quality, "AHRQ National Scorecard on Hospital-Acquired Conditions, Final Results for 2014 Through 2017", using 2019 estimated occurrence rates per 1000 discharges, report published 2017

[24] American Hospital Association, "Fast Facts on U.S. Hospitals, 2022", https://www.aha.org/statistics/fast-facts-us-hospitals

[25] MedPac, "Report to Congress: Medicare Payment Policy", March 2021

Event	Estimated occurrence / 1000 discharges	Total occurrences	Cost Per Event	Total
Pressure Ulcers	23	722,200	19,500	$14,082,900,000
Adverse Drug Event	24.2	759,880	7,500	$5,699,100,000
CAUTI	5.4	169,560	16,000	$2,712,960,000
Surgical Site Infection	2.5	78,500	30,000	$2,355,000,000
Falls	7.6	238,640	9,000	$2,147,760,000
Ventilator-Associated Pneumonia	1	31,400	60,000	$1,884,000,000
C. Difficile infection	1.8	56,520	22,000	$1,243,440,000
VTE	0.7	21,980	33,000	$725,340,000
CLABSI	0.27	8,478	62,000	$525,636,000
Obstetric Adverse Events	2.2	69,080	800	$55,264,000
			Total	$31,431,400,000

Figure 5: Estimated occurrence and cost of Hospital-Acquired Conditions in the US

AI-based benchmarking will likely be most valuable if it can lead to quality improvement in these high-cost hospital-acquired condition categories shown in Figure 5.

Hospital Acquired Condition Reduction Program

CMS also addressed HACs through the HACRP, which was introduced in 2015. CMS applies a 1% penalty to total CMS Medicare Part A funding given to each hospital if its scores in the bottom quartile of all Medicare Part A (IPPS) hospitals based on its Total HAC score, which is a composite of CMS Patient Safety Indicator (PSI-90) and CDC National Healthcare Safety Network Hospital-Associated Infection (NHSN HAI) measures[26]. There is a broad overlap between the conditions targeted by HAC(POAI) and HACRP, although the exact list can change year to year and is published in the applicable Final Rule.

HACRP is currently temporarily suspended in FY2023: hospitals still provide data, but CMS is not penalizing hospitals based on their score.

Based on analysis of the CMS Medicare Inpatient Hospitals - by Provider and Service 2020 dataset, CMS paid an average of $26,040,261 to hospitals nationwide under Medicare Part A in 2020[27]. A total of 780 hospitals were penalized under HACRP in 2020, for an average of $260K penalty per hospital or $200M in total penalties.

CMS does not publicly publish the Total HAC score of hospitals. However, it does publish some quality statistics under "Medicare Care Compare"[28]. Statistics on NHSN HAI measures are also available on a per-hospital basis[29]. Candidate hospitals for AI-supported quality improvement could be identified using these two resources.

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[26] CMS, "Hospital-Acquired Condition Reduction Program Fiscal Year 2023 Fact Sheet", 2023

[27] CMS, "Medicare Inpatient Hospitals - by Provider and Service" dataset 2020

[28] CMS, "Care Compare", 2023

[29] CMS, "Hospital Associated Infections - Hospital", 26 April 2023

AI-based benchmarking may help hospitals in the bottom quartile of Total HAC score improve and thus avoid the penalties under HACRP.

Merit-Based Incentive Payment System

HAC(POAI) and HACRP are both incentives under Medicare Part A - ie, focused on hospitals. The Quality Payment Program (QPP) Merit-Based Incentive Payment System (MIPS) is administered under Medicare Part B, which applies to individual providers, primarily physicians. MIPS provides bonus or malus on Medicare Part B Fee For Service payments based on a provider's annual MIPS Score. Providers can nominate to submit data and be scored by CMS as individuals, or as a group. In 2020, approximately 51% of MIPS-eligible clinicians participated in MIPS as a group[30].

The MIPS bonus or malus can be worth up to 9% of that provider's Medicare Part B Fee For Service payment[31]. The MIPS score is based on a weighted composite of Quality (30%), Improvement (15%), Cost (30%), Promoting Interoperability (25%)[32]. The score thresholds at which providers receive a bonus or malus vary from year to year. In 2023, clinicians with a score of over 75 points (out of 100) are eligible for a bonus, which averaged 3.71% in 2023. Clinicians with a score below 75 points receive a penalty of up to 9%.

A total of 933,545 clinicians were MIPS eligible in 2020 according to CMS, of whom 535,144 were physicians and 218,463 were practitioners (primarily nurses and psychologists)[33]. Based on 2023 data, according to the American Medical Association, there are 308,000 clinicians who face a MIPS penalty, of whom 75,000 face a MIPS penalty between -3 and -9%[34].

Unlike HAC(POAI) and HACRP, MIPS also considers process quality rather than just outcomes. While the exact measures by which an individual provider is scored vary based on their specialty, MIPS includes 57 outcome-based measures and 136 process-based measures (not all measures apply to all providers). As such, risk-adjustment of outcomes, the primary value-add of Alexandria Health's AI-based benchmarking methodology, is likely less beneficial under MIPS.

This analysis used the CMS Medicare Part B Public Use File for 2020 to identify how much CMS pays to different specialties of physicians and surgeons, on average. For providers who receive, on average, a large amount of Medicare Part B funding, the potential value at stake under MIPS is higher, and therefore the incentive to achieve a higher MIPS score increases.

Focusing on the eight specialties with registries identified in Figure 3, the following table (Figure 6) shows the average Medicare Part B funding per provider in each category. It also calculates the potential value at stake tied to quality under MIPS, on the basis that 45% of the MIPS Score is based on Quality and Improvement, and therefore 45% of the potential bonus/malus can be attributed to Quality and Improvement. This 45% is then applied to the maximum 9%

[30] CMS, "2020 Quality Payment Program Experience Report", 08 August 22
[31] American Medical Association, "Merit-Based Incentive Payment System (MIPS)", 2023
[32] CMS, "Traditional MIPS Overview", 2023
[33] CMS, "2020 Quality Payment Program Experience Report", 08 August 22
[34] American Medical Association, "Merit-Based Incentive Payment System (MIPS)", 2023 – note, the penalty is applied in 2025 based on 2023 results

bonus/malus on total CMS payout. This is on the basis of AI-based benchmarking primarily driving quality improvements rather than cost or interoperability improvements.

As shown in Figure 6, Ophthalmology has the highest potential value at stake per provider under MIPS, followed by Vascular Surgery, Cardiology and Radiology.

Applicable Society	Included Provider Types – CMS codes	Number of unique providers	Average CMS payout per provider per year	Value at stake per provider per year
American Academy of Ophthalmology	'Ophthalmology'	17,192	$357,466.33	$14,477.39
Society of Vascular Surgery	'Vascular Surgery'	3,380	$174,041.67	$7,048.69
American College of Cardiology	Cardiology', 'Intensive cardiac rehabilitation', 'Adult Congenital Heart Disease', 'Peripheral Vascular Disease', 'Clinical Cardiac Electrophysiology', 'Vascular Surgery', 'Advanced Heart Failure and Transplant Cardiology', 'Interventional 'Cardiology', 'Cardiac Surgery'	30,790	$167,743.77	$6,793.62
American College of Radiology	'Radiation Oncology', 'Nuclear Medicine', 'Diagnostic Radiology'	35,525	$128,915.84	$5,221.09
American Academy of Orthopaedic Surgeons	'Orthopedic Surgery'	20,695	$91,783.65	$3,717.24
American Academy of Allergy, Asthma & Immunology	'Allergy/ Immunology'	3,181	$68,676.70	$2,781.41
Society of Thoracic Surgeons	'Thoracic Surgery'	2,140	$60,347.96	$2,444.09
American College of Surgeons	General Surgery', 'Emergency Medicine', 'Critical Care (Intensivists)'	67,373	$41,937.87	$1,698.48
American Psychiatric Association	'Geriatric Psychiatry', 'Psychiatry', 'Neuropsychiatry'	20,058	$34,054.81	$1,379.22

Figure 6: Potential value at stake under MIPS by type of healthcare provider

Medicare Advantage

Medicare Advantage applies to Medicare Part C, which primarily covers seniors aged 65 and older. Under this program, CMS pays private sector healthcare providers a fixed payment based on a risk-adjustment of each beneficiary[35]. The program is intended to incentivize preventative medicine, which generally costs less than treatment.

As Medicare Advantage is administered prospectively, rather than on outcomes, it was not considered within the scope of this report.

[35] CMS, "Understanding Medicare Advantage Plans", accessed May 2023

Assessment Rubric

The following table summarizes the eight fields of medicine with existing registries that are either currently risk-adjusted or currently investigating incorporating risk adjustment. The fields with more unique providers in 2020 are also highlighted – the number of unique providers can be taken as a proxy for how many procedures corresponding to each field of medicine are performed each year. The table also summarizes the applicability of the three main CMS quality incentive programs with a traffic light system.

Field	Registry	Current Risk Adjustment	Number of providers	HAC(POAI) applicability	HACRP applicability	MIPS value at stake p/p
Cardiology & Vascular Surgery	NCDR	Logistic Regression	34,170			$7K
Ophthalmology	IRIS	Investigating	17,192	Not as applicable		$14.5K
General, Trauma and Acute-Care Surgery	NSQIP	Logistic Regression	67,373			$1.7K
Orthopaedic Surgery	Multiple	Assumed Logistic Regression	20,695			$3.7K
Thoracic Surgery	Multiple	Logistic Regression	2,140			$2.4K
Radiology	NRDR	Investigating	35,525	No HAC related to Radiology	No HAC related to Radiology	$5.2K
Allergy, Asthma & Immunology	AAAAI QCDR	Yes; method unknown	3,181	No HAC related to AAI	No HAC related to AAI	$2.8K
Psychiatry	PsychPRO	Yes; method unknown	20,058	No HAC related to Psychiatry	No HAC related to Psychiatry	$1.4K

Figure 7: Assessment rubric for applicability of AI-based benchmarking to different fields of medicine with existing risk-adjusted registries

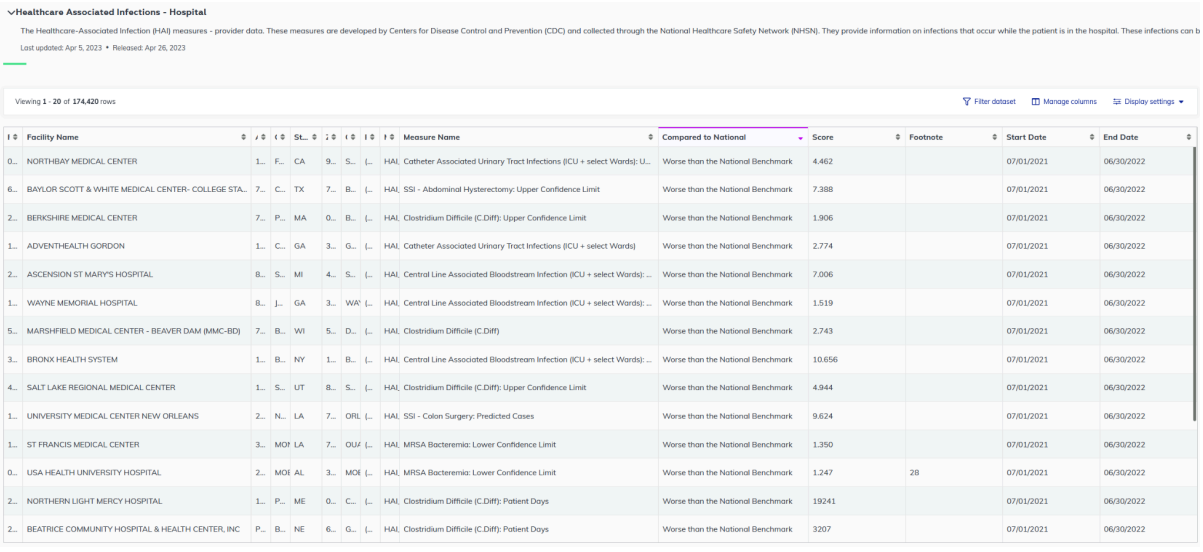
As shown in Figure 7 and previously discussed, not all CMS quality incentive programs are equally applicable to all fields of medicine. Both HAC(POAI) and HACRP are focused on surgery and there are no hospital-acquired conditions or patient safety indicators in either HAC(POAI) or HACRP that are likely to arise from radiology, AAI or psychiatry specifically[36]. MIPS is applicable to all fields of medicine in Figure 7; however, the potential value at stake per provider varies significantly.

AI-based methods for risk-adjustment in benchmarking are likely to be most useful in surgical fields. Two of the three main CMS quality-based incentive systems focus on complications that tend to arise in the context of surgery. The clearer links between surgical quality and quantifiable outcomes make it particularly suited to risk-adjusted benchmarking compared to, for example, psychiatry.

[36] Agency for Healthcare Research and Quality, "Patient Safety Indicator Measures", 2022

Recommendations

1. AI-based benchmarking methods, as developed by Alexandria Health, are most likely to be effective in fields of medicine for which there is already a national registry that is currently using some form of risk adjustment. These currently include cardiology (including vascular surgery), general, trauma and acute-care surgery, orthopedic surgery, thoracic surgery, allergy, asthma & immunology, and psychiatry. Ophthalmology's IRIS registry and radiology's NRDR registry are both exploring incorporating risk adjustment in the near future and are likely also suitable.
2. Alexandria Health has already done AI-based benchmarking using the NSQIP registry, which ranks highly on the measures outlined in Figure 7. The next targets should be cardiology & vascular surgery, ophthalmology and orthopedic surgery, based on these fields being the highest ranked across number of providers (and, likely, procedures conducted) and applicability of CMS quality-based incentive programs.
3. Underperforming hospitals can be identified using CMS's 'Medicare Care Compare' tool and NHSN Healthcare-Associated Infection database. These resources do not directly state the additional cost to the hospital arising from hospital-acquired conditions, under HAC(POAI), or its Total HAC score, under HACRP. Nonetheless, these resources are likely the best publicly available proxy of which hospitals are underperforming, and therefore which hospitals likely have the highest financial incentives to improve quality. Figure 8 provides an example of filtering the database to show hospitals that are performing worse than the national benchmark at various hospital-acquired conditions. Note, however, that neither of these resources provide quality outcome information broken down by field of medicine.



Healthcare Associated Infections - Hospital

The Healthcare-Associated Infection (HAI) measures - provider data. These measures are developed by Centers for Disease Control and Prevention (CDC) and collected through the National Healthcare Safety Network (NHSN). They provide information on infections that occur while the patient is in the hospital. These infections can b

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Viewing 1 - 20 of 174,420 rows

Filter dataset | Manage columns | Display settings

Facility Name	Measure Name	Compared to National	Score	Footnote	Start Date	End Date
NORTHBAY MEDICAL CENTER	Catheter Associated Urinary Tract Infections (ICU + select Wards): U...	Worse than the National Benchmark	4.462		07/01/2021	06/30/2022
BAYLOR SCOTT & WHITE MEDICAL CENTER- COLLEGE STA...	SSI - Abdominal Hysterectomy: Upper Confidence Limit	Worse than the National Benchmark	7.388		07/01/2021	06/30/2022
BERKSHIRE MEDICAL CENTER	Clostridium Difficile (C.Diff): Upper Confidence Limit	Worse than the National Benchmark	1.906		07/01/2021	06/30/2022
ADVENTHEALTH GORDON	Catheter Associated Urinary Tract Infections (ICU + select Wards)	Worse than the National Benchmark	2.774		07/01/2021	06/30/2022
ASCENSION ST MARY'S HOSPITAL	Central Line Associated Bloodstream Infection (ICU + select Wards): ...	Worse than the National Benchmark	7.006		07/01/2021	06/30/2022
WAYNE MEMORIAL HOSPITAL	Central Line Associated Bloodstream Infection (ICU + select Wards): ...	Worse than the National Benchmark	1.519		07/01/2021	06/30/2022
MARSHFIELD MEDICAL CENTER - BEAVER DAM (MMC-BD)	Clostridium Difficile (C.Diff)	Worse than the National Benchmark	2.743		07/01/2021	06/30/2022
BRONX HEALTH SYSTEM	Central Line Associated Bloodstream Infection (ICU + select Wards): ...	Worse than the National Benchmark	10.656		07/01/2021	06/30/2022
SALT LAKE REGIONAL MEDICAL CENTER	Clostridium Difficile (C.Diff): Upper Confidence Limit	Worse than the National Benchmark	4.944		07/01/2021	06/30/2022
UNIVERSITY MEDICAL CENTER NEW ORLEANS	SSI - Colon Surgery: Predicted Cases	Worse than the National Benchmark	9.624		07/01/2021	06/30/2022
ST FRANCIS MEDICAL CENTER	MRSA Bacteremia: Lower Confidence Limit	Worse than the National Benchmark	1.350		07/01/2021	06/30/2022
USA HEALTH UNIVERSITY HOSPITAL	MRSA Bacteremia: Lower Confidence Limit	Worse than the National Benchmark	1.247	28	07/01/2021	06/30/2022
NORTHERN LIGHT MERCY HOSPITAL	Clostridium Difficile (C.Diff): Patient Days	Worse than the National Benchmark	19241		07/01/2021	06/30/2022
BEATRICE COMMUNITY HOSPITAL & HEALTH CENTER, INC	Clostridium Difficile (C.Diff): Patient Days	Worse than the National Benchmark	3207		07/01/2021	06/30/2022

Figure 8: Example of finding hospitals with 'Worse than National Benchmark' scores in different hospital-acquired conditions through the CMS database[37]

[37] CMS, "Hospital Associated Infections - Hospital", 26 April 2023

Society	Members	Registry	Registry Name
American College of Physicians	161,000	N	N/A
Society of General Internal Medicine	3,300	N	N/A
American Academy of Ophthalmology	32,000	Y	IRIS
Society of Vascular Surgery	6,000	Y	NCDR
American College of Chest Physicians	19,000	N	N/A
Society of Cardiovascular Magnetic Resonance	3,000	Y	SCMR Registry
American College of Cardiology	54,000	Y	NCDR
American Academy of Family Physicians	136,700	N	N/A
American Society of Hematology	18,000	N	N/A
American College of Radiology	40,000	Y	NRDR
Society of Critical Care Medicine	16,000	N	N/A
American Academy of Orthopaedic Surgeons	38,000	Y	Multiple
American College of Rheumatology	9,400	Y	RISE
American Society of Nephrology	20,400	N	N/A
American Gastroenterological Association	16,000	N	Upcoming
American Society for Radiation Oncology	10,000	N	N/A
American Urological Association	22,000	Y	AQUA
American Academy of Neurology	38,000	Y	Axon
College of American Pathologists	18,000	N	N/A
Society of Hospital Medicine	18,000	N	N/A
American Association for the Study of Liver Diseases	5,000	N	N/A
American Academy of Allergy, Asthma & Immunology	7,000	Y	AAAAI QCDR
Society of Thoracic Surgeons	7,600	Y	Multiple
Infectious Diseases Society of America	12,000	N	N/A
American Association of Clinical Endocrinology	5,700	N	N/A
American Society for Reproductive Medicine	7,800	N	N/A
American College of Occupational and Environmental Medicine	4,500	N	N/A
American College of Obstetricians and Gynecologists	60,000	N	N/A
American College of Surgeons	84,000	Y	NSQIP
American Thoracic Society	16,000	N	N/A
American Geriatrics Society	6,000	N	N/A
American Psychiatric Association	37,800	Y	PsychPRO
Society of Nuclear Medicine and Molecular Imaging	16,000	N	N/A
American Society of Colon and Rectal Surgeons	1,000	N	N/A
Society of Gynecologic Oncology	2,700	N	N/A
American Academy of Hospice and Palliative Medicine	5,500	N	N/A
American College of Preventive Medicine	2,000	N	N/A
American College of Medical Genetics and Genomics	1,800	N	N/A

American Epilepsy Society	4,600	N	N/A
American Medical Informatics Association	5,600	N	N/A

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