Hospital Visits after Orthopedic Ambulatory Surgical Center Procedures (Version 1.0)

Measure Technical Report

Submitted by:

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1. Executive Summary

This report presents the development, testing, and specifications of a quality measure of orthopedic ambulatory surgical center (ASC) procedures. The measure assesses the quality of orthopedic ASC procedures using the outcome of hospital visits – including emergency department (ED) visits, observation stays, and unplanned inpatient admissions – within 7 days after the surgery. Yale New Haven Health Services Corporation—Center for Outcomes Research and Evaluation (CORE) developed the measure for the Centers for Medicare & Medicaid Services (CMS). This ASC-level measure will inform patient choice and help providers and ASCs improve the quality of care.

This report presents the rationale for the measure, the specific technical approach to the measure, the measure specifications, and the national distribution of measure scores across ASC facilities.

1.1 Rationale for Assessing Hospital Visit after Ambulatory Surgery

Ambulatory surgery is increasingly common in the United States (US). Nearly 70% of all surgeries in the US are performed in an outpatient setting, with an expanding number and variety of procedures being performed at stand-alone ASCs.[1] While ambulatory surgery is considered low risk for complications, there are well described and potentially preventable adverse events that can occur after ambulatory surgery leading to unplanned care in a hospital. These events include uncontrolled pain, urinary retention, infection, bleeding, and venous thromboembolism.

Hospital visits following same-day surgery are an important and accepted patient-centered outcome reported in the literature.[2-9] Estimates of hospital visit rates after outpatient surgery vary from 0.5% to 9.0%, based on the type of surgery, outcome measured (admissions alone, or admissions and ED visits), and timeframe for measurement after surgery. Such events also vary among ASCs, suggesting possible variation in surgical and discharge quality of care.[6,10-18] Providers at ASCs are often unaware of patients' subsequent acute care visits given that patients tend to present to the ED or to hospitals unaffiliated with the ASC.[19]

We estimated the unadjusted 7-day rate of hospital visits, as defined for this measure, following orthopedic ASC procedures. In our analysis of a national 100% dataset of Medicare Fee-for-Service (FFS) claims from Fiscal Year (FY) 2015 (October 1, 2014 – September 30, 2015), the median national observed facility rate of any unplanned hospital visit within 7 days following orthopedic procedures performed at ASCs was 2.5% (the 25th and 75th percentiles were 0.0% and 3.2%, respectively). These results suggest a performance gap and opportunity

for quality improvement. The median outcome rates specifically for ED or observation stay visits and for unplanned inpatient admissions were 1.9% and 0.6%, respectively.

For these reasons, a quality measure of hospital visits following orthopedic ASC surgery will serve to improve transparency, inform patients and providers, and foster quality improvement efforts.

1.2 Measure Development

This measure was developed consistent with CMS's measure development guidance. The primary measure developers, a multidisciplinary team of clinicians, health services researchers, and statisticians, were supported and informed by a national technical expert panel (TEP) consisting of patients, surgeons, methodologists, researchers, and providers. We also held a public comment period soliciting stakeholder input on the measure methodology and publicly posted a summary of the comments received as well as our responses (available in the Downloads section at https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/CallforPublicComment.html).

1.3 Measure Specifications

The population of interest for the measure is Medicare Fee-for-Service (FFS) patients aged 65 years and older undergoing outpatient orthopedic surgery at ASCs.

The measure's outcome is any unplanned hospital visit (ED visit, observation stay, or unplanned inpatient admission) by a patient occurring within 7 days of an index procedure (a patient's initial procedure).

The measure is risk adjusted. In order to ensure that differences in facilities' measure scores do not just reflect differences in the mix of patients and procedures across ASCs, the model adjusts for patient demographics (age and sex) and comorbidities as well as surgical procedural complexity. We adjust for these characteristics because they vary across ASC patient populations, are unrelated to quality, and influence the outcome.

The measure score is an ASC-level risk-standardized hospital visit rate (RSHVR). The RSHVR is calculated as the ratio of the predicted to the expected number of post-surgical unplanned hospital visits among an ASC's patients, multiplied by the national observed rate of unplanned hospital visits. For each ASC, the numerator of the ratio is the number of hospital visits predicted for the ASC's patients, accounting for its observed rate, the number and complexity of orthopedic procedures performed at the ASC, and the case mix. The denominator is the number of hospital visits expected nationally for the ASC's case and procedure mix. To calculate an ASC's predicted-to-expected (P/E) ratio, the measure uses a two-level hierarchical logistic

regression model. The log-odds of the outcome for an index procedure is modeled as a function of the patient demographic, comorbidity, and procedure characteristics as well as a random ASC-specific intercept. A ratio greater than one indicates that the ASC's patients have more post-surgical hospital visits than expected, compared to an average ASC with similar patient and procedural complexity. A ratio less than one indicates that the ASC's patients have fewer post-surgical hospital visits than expected, compared to an average ASC with similar patient and procedural complexity. An ASC's P/E ratio is then multiplied by the overall national 7-day rate of unplanned hospital visits to calculate the ASC-level RSHVR. This approach is analogous to an observed-to-expected ratio, but accounts for within-facility correlation of the observed outcome and for sample size differences across facilities; and accommodates the assumption that underlying differences in quality across ASCs lead to systematic differences in outcomes.

1.4 Distribution of Measure Scores

There was variation in risk-standardized scores across ASCs nationally. In a national Medicare FFS claims dataset for FYs 2014-2015 that included 379,046 procedures at 2,734 ASCs, the facility measure scores ranged from 1.8% to 3.8%, with a median RSHVR of 2.5% (the 25th and 75th percentiles were 2.4% and 2.6%, respectively).

1.5 Summary

This report describes the measure specifications and results for a risk-standardized quality measure of 7-day unplanned hospital visits following orthopedic ASC procedures. Stakeholder and expert input informed measure development throughout. The purpose of this measure is to illuminate variation in performance as an indication of variation in quality of care for orthopedic surgeries across ASCs, inform patient choice, and drive quality improvement.

2. Introduction

2.1 Background

National efforts to measure the quality of ambulatory surgical care are essential given the increasing number of ambulatory surgical centers (ASCs) in the United States (US) and the increasing variety of procedures performed at ASCs. ASCs have become the preferred setting for the provision of low-risk surgical and medical procedures in the US, including the provision of many types of orthopedic surgical care.[1] ASCs have gained favor among patients given their tendency toward shorter wait times, decreased need for hospitalization, and more rapid return to work when compared to similar patients managed in other types of healthcare facilities.[1] In 2015 alone, more than 3.4 million Medicare Fee-for-Service (FFS) beneficiaries received care at 5,475 ASCs.[20] Associated spending on ASC services for all types of procedures by Medicare per beneficiary increased by an average of 2.8% per year between 2010 and 2014, and by 5.2% in 2015, resulting in a total expenditure of $4.1 billion spent on ASC services in 2015.[20] Due to advances in surgical and anesthetic techniques, nearly 70% of all surgical procedures in the US are performed in outpatient settings, with many of these procedures taking place as same-day surgeries at ASCs.[1] The resultant shift in ASC utilization has led to an increase not only in ASC operative volume, but also in the average age and complexity of patients managed at ASCs.[21,22]

Orthopedic procedures are commonly performed at ASCs. Based on our empiric analyses of Medicare FFS patients aged 65 years and older, from October 1, 2014 through September 30, 2015, 2,523 ASCs performed 189,806 outpatient orthopedic procedures of the type included in this measure (see accompanying Microsoft Excel file for a complete listing of procedure codes included in the measure cohort); 1,402 (55.6%) of those ASCs performed at least 30 such procedures.

2.2 Definition of an Ambulatory Surgical Center (ASC)

Medicare defines ASCs as healthcare facilities that operate “exclusively for the purpose of providing surgical services to patients not requiring hospitalization and in which the expected duration of services [does] not exceed 24 hours following an admission” (42 CFR 416.2). Of interest for the measure, the types of orthopedic procedures performed at ASCs range from very minor procedures, such as setting of a facture, to more major operations, such as reconstruction of an elbow joint. These procedures typically have less than 90-minute operating times and 4- to 6-hour same-day recovery periods. The surgeries performed usually do not (1) involve major or prolonged invasion of body cavities; (2) require active medical monitoring and care overnight; (3) result in extensive blood loss; (4) directly involve major blood vessels; or (5) involve care that is either emergent or life-threatening (42 CFR 416.65).

Eligible ASCs vary in their organizational and financial structures. Many ASCs are hospital-owned; most are run by groups of physicians in the same specialty area and are limited to a single type of procedure, such as eye or orthopedic surgery. Other ASCs conduct procedures in two or more specialty areas.

2.3 Importance of Assessing Hospital Visits after ASC Procedures

Despite increasing availability of ASCs and their use by patients, there are few quality measures to gauge ASC performance. Existing ASC quality measures tend to focus on very rare, patient safety-related events. For example, one measure counts cases in which a wrong site, wrong side, wrong patient, wrong procedure, or wrong implant event occurred.[23] While such rare patient safety-related events are important to assess, generally lacking at this time are measures designed to capture more common adverse outcomes that patients experience, such as pain, bleeding, urinary retention, and other complications, prompting acute care hospital visits or admissions.

Measuring ASC outcomes is an important strategy for improving transparency and fostering quality improvement. Facilities and surgical teams may be unaware of their patients' adverse events and hospitalizations following ASC procedures because separate providers (for example, emergency department physicians) tend to provide post-surgical care when it is required. For this reason, measuring unanticipated hospital visits following ASC procedures offers an important means of more broadly reflecting the quality of ASC care. Such visits are an unexpected and potentially preventable outcome for patients with low anticipated perioperative risk.

In the literature, hospital visit rates following outpatient surgery vary from 0.5% to 9.0%, based on the type of surgery, outcome measured (admissions alone, or admissions and emergency department [ED] visits), and timeframe for measurement after surgery.[2-9,24] These hospital visits can occur due to a range of well-described adverse events, including major adverse events, such as bleeding, wound infection, septicemia, and venous thromboembolism. Patients also frequently report minor adverse events – for example, uncontrolled pain, nausea, and vomiting – that may result in unplanned acute care visits following surgery.

Several factors make unanticipated hospital visits a priority quality indicator. Because ASC providers are not aware of all post-surgical hospital visits that occur among their patients, reporting of this outcome will help to illuminate problems that may not be currently visible. In addition, the outcome of hospital visits is a broad, patient-centered outcome that reflects the full range of reasons leading to hospital use among patients undergoing same-day surgery. Public reporting of this outcome measure will provide ASCs with critical information and incentives to implement strategies to reduce unplanned hospital visits.

Given that ASCs vary widely in their focus and the number of procedures that they perform, focusing on a specific surgical subspecialty area, such as orthopedic surgery, enables use of a quality measure to make fair comparisons of outcome rates across facilities that perform similar procedures.

2.4 Related Measures Under Development

This measure of 7-day unplanned hospital visits following orthopedic procedures performed at ASCs was developed in conjunction with a quality measure that focuses on urology ASC procedures and utilizes the same hospital visits outcome. This hospital visits outcome is also the focus of two existing, National Quality Forum (NQF)-endorsed CMS quality measures: (1) Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy (NQF #2539) and (2) Hospital Visits after Hospital Outpatient Surgery (NQF #2687).

3. Measure Development Methods

3.1 Overview of Measure Development Process

Yale New Haven Health Services Corporation – Center for Outcomes Research and Evaluation (CORE) led the development of the orthopedic ASC measure under the guidance of CMS. The CORE Project Team consisted of a multidisciplinary group of clinicians, health services researchers, and statisticians with expertise in outcome measure development. We obtained clinical input from an orthopedic consultant and convened, through a public process, a national Technical Expert Panel (TEP) consisting of patients, expert clinicians, methodologists, researchers, and providers to give input on the measure methodology. Additionally, a public comment period was held to solicit stakeholder input on the measure methodology.

3.2 Data Sources

The measure requires a data source that allows us to link patient data across care settings in order to identify appropriate surgical procedures for inclusion, comorbidities for risk adjustment, and the outcome of hospital visits.[23–25] Therefore, claims data are used, as they support these linkages and are available for the patient population of interest. Furthermore, facilities do not need to submit any data to CMS because claims data are used to calculate the measure results.

To develop and test the patient-level model, we used a national dataset of Fiscal Year (FY) 2015 (October 1, 2014 – September 30, 2015) claims data from the Health Account Joint Information (HAJI) database that included Medicare Inpatient, Outpatient, and Carrier (Part B Physician) claims (hereinafter, Medicare FFS FY 2015 Dataset). Outpatient orthopedic procedures performed at ASCs were identified using the full set of Medicare beneficiaries' claims from the Carrier non-institutional claims, which includes the ASC facility claim (with a unique facility identifier). The outcomes of ED visits and observation stays after orthopedic ASC surgery were identified from the hospital outpatient institutional claims, and the outcome of inpatient hospital admissions was identified from the inpatient institutional claims. The measure cohort included patients who underwent orthopedic ASC procedures in FY 2015. Inpatient and outpatient claims data from the year prior (FY 2014: October 1, 2013 – September 30, 2014) were used to identify comorbidities for risk adjustment for these patients.

For public reporting, CMS is planning to use 2 years of data to increase the reliability of the measure score. Therefore, to calculate ASCs' measure scores, we used 2 years of claims data from FYs 2014 and 2015 (October 1, 2013 – September 30, 2015; hereinafter, Medicare FFS FYs 2014-2015 Dataset). To calculate measure score reliability for a 2-year reporting period, we used 4 years of claims data from FYs 2012-2015 (October 1, 2011 – September 30, 2015), and

randomly split the dataset into two samples, with each containing the equivalent sample size of 2 years of data.

3.3 Cohort Definition

The target population for this measure is Medicare FFS patients aged 65 years and older undergoing outpatient orthopedic surgeries, typically performed by an orthopedist, at ASCs. The Medicare FFS population was chosen because of the availability of a national dataset (Medicare claims) that could be used to develop, test, and publicly report the measure. The target population is defined based on the following inclusion and exclusion criteria.

3.3.1 *Inclusion Criteria*

Included patients

- Medicare FFS patients aged 65 years and older.

  Rationale: Medicare beneficiaries under age 65 typically are a highly diverse group with a higher burden of disability, and it is therefore difficult to adequately risk adjust for the under-65 population.

- Patients with continuous enrollment in Medicare FFS Parts A and B in the 12 months prior to the surgery.

  Rationale: Patients with full enrollment have all claims available for identifying comorbidities for risk adjustment.

Included procedures

- Our target group of procedures was surgical procedures that (1) are routinely performed at ASCs, (2) involve increased risk of post-surgery hospital visits, and (3) are routinely performed by orthopedists.
  - The measure includes a subset of procedures performed at ASCs identified using Medicare's list of covered ASC procedures for 2014 and 2015. This list of surgeries is publicly available at: https://www.cms.gov/medicare/medicare-fee-for-service-payment/ascpayment/11_addenda_updates.html (download Addendum AA). Surgeries on the ASC list of covered procedures do not involve or require major or prolonged invasion of body cavities, extensive blood loss, major blood vessels, or

care that is emergent or life-threatening.[i]

- To focus the measure on "major" and "minor" surgeries that impose a meaningful risk of post-procedure hospital visits, we use the Medicare Physician Fee Schedule global surgery indicator (GSI) values of 090 and 010, respectively. The GSI code reflects the number of post-operative days that are included in a given procedure's global surgical payment and identifies surgical procedures of greater complexity and follow-up care. Minor/non-surgical procedures coded GSI 000 are not included in the measure cohort. This list of GSI values is publicly available at: https://www.cms.gov/Medicare/Medicare-fee-for-service-payment/physicianfeesched/pfs-federal-regulation-notices-items/cms-1590-fc.html (download Addendum B).

- To identify the subset of ASC procedures typically performed by orthopedic surgeons, we use the Clinical Classifications Software (CCS) developed by the Agency for Healthcare Research and Quality (AHRQ) and its "operations on the musculoskeletal system" group of procedures.[25] Procedures to treat a facial fracture or dislocation (defined by AHRQ clinical category CCS 144) were removed because our experts indicated that these procedures are typically performed by plastic surgeons; ear, nose, and throat surgeons; and oral maxillofacial surgeons.

With the exception of CCS 144, the orthopedic ASC measure cohort includes all other major and minor surgical procedures in AHRQ's "operations on the musculoskeletal system" group. See the accompanying Microsoft Excel file for a complete listing of all Current Procedural Terminology (CPT®) procedure codes included in the measure cohort. This Microsoft Excel file is available within the same zipped folder as this report.

3.3.2 *Exclusion Criteria*

- Surgeries for patients who survived at least 7 days, but were not continuously enrolled in Medicare FFS Parts A and B in the 7 days after the surgery are excluded.

  Rationale: These patients are excluded to ensure all patients have full data available for outcome assessment.

[i] This list of surgeries was used for several reasons. The ASC list is publicly available, is annually reviewed and updated by Medicare, and includes a transparent public comment submission and review process for addition and/or removal of procedures. Using an existing, defined list of same-day surgical procedures, rather than defining surgical procedures de novo, is useful for long-term measure maintenance. Procedures included on Medicare's list of covered ASC procedures are defined using Healthcare Common Procedure Coding System (HCPCS) and Current Procedural Terminology (CPT®) codes.

3.4 Outcome

3.4.1 *Definition of Outcome*

The outcome is any unplanned hospital visit within 7 days of an outpatient orthopedic surgery. The outcome of hospital visits is the focus of this measure because this is a broad, patient-centered outcome that captures the full range of hospital visits resulting from adverse events or poor care coordination following outpatient surgery. This measure's goal is to assess and to illuminate variation in risk-adjusted hospital visits following surgery for quality improvement purposes.

A hospital visit is defined as any ED visit, observation stay, or unplanned inpatient admission occurring after the ASC procedure (see Table A1); "planned" admissions for anticipated care are not included, as these hospital visits do not reflect quality differences (see Section 3.4.5). Hospital acute care visits and admissions are well-described and recognized indicators of quality for outpatient surgery at ASCs (see Section 2.3).

We have developed two other risk-adjusted outpatient procedure measures that use this same 7-day unplanned hospital visit outcome, both of which have been endorsed by the NQF and have been finalized for use in CMS's pay-for-reporting programs:

- Facility 7-Day Risk-Standardized Hospital Visit Rate after Outpatient Colonoscopy (NQF #2539)
- Hospital Visits after Hospital Outpatient Surgery (NQF #2687)

ED visits and observation stays are defined using billing codes or revenue center codes identified in Medicare Part B outpatient hospital claims (see Appendix A).

3.4.2 *Outcome Timeframe*

The outcome of hospital visits is limited to 7 days since existing literature suggests that the vast majority of adverse events after outpatient surgery occur within the first 7 days following the surgery.[4,26] In addition, our data analysis showed the highest rates of hospital visits occurring within 7 days of outpatient orthopedic surgery. As the results in Figure 1 show, the daily rate of unplanned hospital visits was highest (4.8 visits per 1,000 procedures) immediately following the procedure and leveled off to a baseline rate of 2.1 visits per 1,000 procedures after 7 days. Based on empiric analyses and expert input from our orthopedic consultant and TEP members, we concluded that unplanned hospital visits within 7 days is the optimal timeframe to ensure capture of surgery-related adverse events and to minimize capture of hospital visits unrelated to the surgery.

3.4.3 *Multiple Qualifying Procedures within a 7-Day Period*

In rare instances (0.11%), an index procedure is followed by another qualifying ASC orthopedic procedure within 7 days. When there are two or more qualifying surgical procedures within a 7-day period, the measure considers all procedures as index procedures; however, the timeframe for outcome assessment is defined as the interval between procedures (including the day of the next procedure) and then 7 days after the last procedure. If the timeframe for outcome assessment were 7 days after each procedure that occurs within a 7-day period, it would be possible for a single outcome to be attributed to two or more index procedures. For example, consider the following scenario: Procedure #1 on Day 1, Procedure #2 on Day 4, and ED visit on Day 6. Using the standard 7-day timeframe, the outcome on Day 6 would get attributed to both of the procedures. Using the refined coding, however, the outcome on Day 6 would get attributed to only Procedure #2, and Procedure #1 would not have an outcome because there was no unplanned hospital visit between Procedures #1 and #2.

3.4.4 *All-Cause Hospital Visits*

We measure all-cause hospital visits to encourage facilities to minimize all types of risks that may lead to the need for a hospital visit after ASC surgery. Measuring only hospital visits that are overtly related to a procedure, such as pain and bleeding, would limit the measure's impact on quality improvement efforts. Measuring all-cause patient outcomes encourages facilities to minimize the risk of a broad range of outcomes, including the risk of dehydration, nausea and vomiting, dizziness, and urinary retention. These are common problems that may or may not be related to a recent ASC surgery. Thus, the measure is structured so that facilities that most effectively minimize patient risk of these outcomes will perform better on the measure.

The rate of hospital visits is not expected to be zero since some patients will have visits for reasons completely unrelated to the procedure. The measure is risk adjusted for patient demographics, clinical characteristics, and surgical procedural complexity so that facilities that experience more unrelated visits due to a generally higher-risk patient mix are not disadvantaged.

3.4.5 *Removal of Planned Admissions from the Outcome*

For inpatient admissions occurring after outpatient orthopedic surgery at ASCs, only unplanned admissions are included in the measure outcome. "Planned" admissions are those planned by providers for anticipated medical treatment or procedures that must be provided in the inpatient setting; these are not included in the outcome because variation in planned admissions does not reflect quality of care differences.

To identify admissions as planned or unplanned, we applied an algorithm previously developed for CMS's hospital readmission measures, the CMS Planned Readmission Algorithm Version 4.0. In brief, the algorithm uses the procedure codes and principal discharge diagnosis code on each hospital claim to identify admissions that are typically planned. A few specific, limited types of care are always considered planned (for example, major organ transplant, rehabilitation, or maintenance chemotherapy). Otherwise, a planned admission is defined as a non-acute admission for a scheduled procedure (for example, total hip replacement or cholecystectomy). Post-discharge admissions for an acute illness or for complications of care are never considered planned.

See Appendix B for the detailed planned admission algorithm.

3.5 Model Development

3.5.1 *Overview*

The measure adjusts for case-mix differences across facilities based on patient demographics, clinical characteristics, and surgical procedural complexity. Risk adjustment is necessary to ensure that variation in the measure score among ASCs is due to differences in quality of care rather than differences in case mix.

The measure score is an ASC-level risk-standardized hospital visit rate (RSHVR). The RSHVR is calculated as the ratio of the predicted to the expected number of post-surgical unplanned hospital visits among an ASC's patients, multiplied by the national observed 7-day rate of unplanned hospital visits. For each ASC, the numerator of the ratio is the number of hospital visits predicted for the ASC's patients, accounting for its observed rate, the number and complexity of orthopedic procedures performed at the ASC, and the case mix. The denominator is the number of hospital visits expected nationally for the ASC's case and procedure mix. To calculate an ASC's predicted-to-expected (P/E) ratio, the measure uses a two-level hierarchical logistic regression model (see Appendix C). The log-odds of the outcome for an index procedure is modeled as a function of the patient demographics, clinical comorbidities, and procedure characteristics, as well as a random ASC-specific intercept. A ratio greater than one indicates that the ASC's patients have more post-surgical hospital visits than expected, compared to an average ASC with similar patient and procedural complexity. A ratio less than one indicates that the ASC's patients have fewer post-surgical visits than expected, compared to an average ASC with similar patient and procedural complexity. An ASC's P/E ratio is then multiplied by the overall national 7-day rate of unplanned hospital visits to calculate the ASC-level RSHVR. This approach is analogous to an observed-to-expected ratio, but accounts for within-facility correlation of the observed outcome and for sample size differences across facilities; accommodates the assumption that underlying differences in quality across ASCs lead to

systematic differences in outcomes; and is tailored to and appropriate for a publicly reported outcome measure as articulated in published scientific guidelines.[27-29]

3.5.2 *Candidate Risk Factors for Patient-Level Risk Adjustment*

The measure adjusts for differences across facilities in patient demographics, clinical factors, and procedure-related risk. Potential candidate risk factors were identified from related quality measures and the literature; a preliminary list of risk factors was developed and then revised based on TEP and expert clinical input.

The initial list of candidate risk factors included those evaluated in the development of several related claims-based measures: (1) Hospital Visits after Hospital Outpatient Surgery (NQF #2687); (2) Hospital-Level 30-day, All-Cause Risk-Standardized Readmission Rate following Elective Primary Total Hip Arthroplasty and/or Total Knee Arthroplasty (NQF #1551); and (3) Hospital-Level Risk-Standardized Complication Rate following Elective Primary Total Hip Arthroplasty and/or Total Knee Arthroplasty (NQF #1550).

To identify additional clinical and procedural risk factors, the Project Team conducted a focused literature search. Specifically, relevant peer-reviewed publications of claims-based variables predicting hospital visits after outpatient surgery were identified by searching Ovid MEDLINE. The search yielded a total of two studies relevant to the orthopedic measure. We considered adding risk factors from the literature to our candidate risk factors if they were significantly associated with the outcome of interest (unplanned hospital visits) in bivariate or multivariable analyses at the 0.05 level. From the two studies, two variables not included in any of the related measures were identified: prior hospital inpatient admission[4] and Deyo's modification of the Charlson Comorbidity Index.[30] We did not add prior hospitalizations to the list of candidate risk factors since access to and use of hospital services vary widely across the country. In addition, we did not consider the Deyo-adapted Charlson Comorbidity Index because it is a risk-adjustment index that has overlapping content with our candidate variables.

To operationalize the candidate risk factors, we defined the clinical risk factors in claims data using Version 22 of CMS's hierarchical condition categories (HCC) model, which classifies over 15,000 International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes into clinically coherent condition categories. In some cases (for example, morbid obesity), individual ICD-9-CM codes were used to define the risk factor. To address surgical procedural complexity, we used the work Relative Value Units (work RVUs) of the procedure, an approach employed by the American College of Surgeons National Surgical Quality Improvement Program (NSQIP).[31]

The Project Team reviewed the candidate risk factors with TEP members. None of the clinical experts suggested removing any of the candidate risk factors from the list. One of the TEP members suggested considering additional clinical risk factors that the American Association of Hip and Knee Surgeons (AAHKS) has recommended for risk adjusting inpatient hip and knee arthroplasty outcome measures, including smoking, chronic anticoagulant use, previous intra-articular infection, congenital hip deformity, angular knee deformity greater than 15 degrees, and previous open reduction and internal fixation of hip and knee. We did not include workers' compensation status in the list of candidate risk variables. Although workers' compensation status may be correlated with the outcome, the relationship is affected by a number of factors that we do not want to adjust for in this quality measure, including variation in eligibility for workers' compensation by state.

Finally, to consolidate like risk factors into candidate variables, we checked the bivariate direction and strength of association of the individual risk factors defined by condition categories (CCs) or ICD-9-CM codes and then combined risk factor diagnoses into clinically coherent comorbidity variables. For example, a "cancer" variable was created that combined several individual cancer diagnoses.

The list of candidate risk variables is in Appendix D, Table D1. The CCs that are not risk-adjusted for if they occur only at the time of the procedure are in Appendix D, Table D2.

3.5.3 *Final Risk-Adjustment Variable Selection*

For development and testing of the patient-level model, we randomly split the Medicare FFS FY 2015 Dataset into Development and Validation Samples. The Development Sample included a random 70% and the Validation Sample included the remaining 30% of the orthopedic ASC procedures contained in the FY 2015 data.

To select the final set of variables to include in the risk-adjustment model, risk variables significant at $p \leq 0.25$ in bivariate analysis were entered into logistic regression analyses predicting the outcome of hospital visits within 7 days in the Development Sample. As noted above, the Development Sample was a randomly selected 70% sample of our FY 2015 Medicare cohort. To develop a parsimonious risk model, non-significant variables (at the 0.05 level) were iteratively removed from the model using a stepwise purposeful selection approach described by Hosmer and Lemeshow.[32] All variables significant at $p<0.05$ were retained in the final model. In addition, we retained in the model two variables (tobacco use disorder and morbid obesity) because experts advised that these were important risk predictors and expressed a strong preference for including them in the model.

3.5.4 *Model Performance and Validation*

To assess performance of the patient-level risk-adjustment model in the Development Sample, the area under the receiver operating characteristic curve as measured by the c-statistic was calculated. Observed hospital visit rates were compared to predicted hospital visit probabilities across predicted risk deciles to assess calibration, and the range of observed hospital rates between the lowest and the highest predicted deciles was also calculated to assess model discrimination.

Several analyses to validate the patient-level risk-adjustment model were performed. First, we compared model performance in the Development Sample with its performance in the Validation Sample. The c-statistic, model information criteria (Akaike Information Criteria [AIC], Bayesian Information Criteria [BIC]), and model discrimination (predictive ability) were compared.[33] Second, we examined the stability of the risk variable frequencies and regression coefficients across the development and validation datasets. Third, we calculated over-fitting indices in the Validation Sample. Over-fitting refers to the phenomenon in which a model describes the relationship between predictive variables and the outcome well in the development dataset but fails to provide valid predictions in new patients. Estimated calibration values of γ_0 far from 0 and estimated values of γ_1 far from 1 provide evidence of over-fitting.

3.5.5 *Calculation of ASC-Level Measure Score*

We examined different distributions (Normal, T, Exponential, and Gamma distributions) of random effects in the hierarchical logistic regression model by evaluating model DIC (Deviance Information Criteria). The hierarchical model with normally distributed random effects had the lowest DIC and was used to calculate ASC-level measure scores.

ASCs' measure scores were calculated in the Medicare FFS FYs 2014-2015 Dataset. As noted above in Section 3.5.1, we calculated the RSHVR for each ASC by computing the ratio of the number of predicted unplanned hospital visits to the number of expected unplanned hospital visits and then multiplying the ratio by the national outcome rate in the Medicare FFS FYs 2014-2015 Dataset. Then, we evaluated variation in the risk-adjusted measure scores among ASCs.

3.5.6 *Facility-Level Measure Score Reliability Testing*

To calculate measure score reliability for a 2-year reporting period, we used 4 years of claims data from FYs 2012-2015 (October 1, 2011 – September 30, 2015). Data for ASCs with two or more orthopedic procedures during the 4-year period were randomly split into two samples within each facility, yielding patient samples per facility that were equivalent in size to 2 years

of data. Reliability of the ASC-level measure score was tested by calculating the intra-class correlation coefficient (ICC). Since we are measuring the underlying quality of orthopedic procedures at the ASC using patient outcomes, the measure score calculated using two independent samples of patients from the facility should generate scores that are similar. The ICC evaluated the agreement between the RSHVR calculated in the two randomly selected samples.[34]

3.5.7 *Disparities Testing*

Using the Medicare FFS FY 2015 Dataset, we evaluated the potential impact of race and socioeconomic status (SES) on the orthopedic ASC measure score. We assessed the relationship of SES to hospital visits at the patient and facility levels.

First, at the patient level, we assessed whether risk adjustment for Medicaid dual-eligibility status, African-America race, or a composite measure of SES (AHRQ-validated SES index[35]) affected ASC measure scores by comparing the facility-specific measure score with and without adjustment for each of these variables.

Second, at the ASC-level, we assessed whether ASCs with a high proportion of dual-eligible patients, African-American patients, or low-SES patients (as identified by the AHRQ SES index) performed as well on the measure as ASCs with lower proportions of these patients. To perform this ASC-level analysis, we categorized ASCs into quartiles based on the proportions of Medicaid dual-eligible patients, African-American patients, and low-SES patients, and then examined the distribution of measure scores across the lowest and highest quartiles.

These analyses were performed using the Medicare FFS FY 2015 Dataset and data from the Census Bureau's American Community Survey. Specifically, we used the 2009-2013 American Community Survey to calculate AHRQ SES index scores and mapped them to patients' nine-digit ZIP codes.

3.5.8 *Face Validity Testing*

We systematically assessed the face validity of the measure score as an indicator of quality by confidentially soliciting the TEP members' agreement with the following statements (via an online survey):

- "The risk-standardized hospital visit rates obtained from the 'Hospital Visits after Orthopedic Ambulatory Surgical Center Procedures' measure as specified are valid and useful measures of ASC orthopedic surgical quality of care."

- "The risk-standardized hospital visit rates obtained from the 'Hospital Visits after Orthopedic Ambulatory Surgical Center Procedures' measure as specified will provide ASCs with information that can be used to improve their quality of care."

Response options ranged from "strongly disagree" to "strongly agree."

3.5.9 *Statistical Software*

All statistical analyses were performed using Statistical Analysis System (SAS) version 9.4 (SAS Institute Inc., Cary, NC). We used both GLIMMIX and Markov Chain Monte Carlo (MCMC) procedures in SAS for identifying the optimal model for this measure. The final hierarchical logistic regression model was estimated using the GLIMMIX procedure in SAS.

4. Results

4.1 Overall Summary

After applying all inclusion and exclusion criteria, the Medicare FFS FY 2015 Dataset included 189,806 outpatient orthopedic surgeries performed at 2,523 ASCs. The Development and Validation Samples consisted of 132,865 and 59,941 orthopedic procedures performed at 2,450 and 2,269 ASCs, respectively. In both the Development and the Validation Samples, the average age of patients was 73.1 years, and the comorbidity frequencies were similar (Table 1).

Table 2 presents the top 20 most common surgeries included in the Medicare FFS FY 2015 Dataset (FY 2015 orthopedic ASC measure cohort); they represent 64.7% of all surgeries in the cohort.

In the Medicare FFS FY 2015 Dataset, the overall national 7-day unplanned hospital visit rate was 2.5%, including 1.9% for ED or observation stay visits and 0.6% for unplanned inpatient admissions (Table 3).

Across ASCs in the Medicare FFS FY 2015 Dataset, the median number of orthopedic surgery cases was 38, with the volume of cases ranging from 1 to 1,003 procedures per ASC (the 25th and 75th percentiles were 8 and 102 procedures, respectively).

These results show that there were many small-volume ASCs in the Medicare FFS FY 2015 Dataset; 1,121 ASCs (44.4%) had fewer than 30 cases. Among the 1,402 ASCs with at least 30 patients, the unadjusted rate of unplanned hospital visits across ASCs ranged from 0.0% to 15.6%. Of these ASCs, 191 ASCs (14.1%) had a hospital visit rate of 0.0%; however, the top 10% of ASCs with 30 or more cases had rates exceeding 5.0%. While many ASCs achieve very low rates, there is a performance gap, as evidenced by variation in performance across ASC facilities. In addition, the median rate of 2.5% suggests room for improvement for the group as a whole, given that patients undergoing procedures at ASCs do not expect to need acute hospital care within the week following the procedure.

Patients visited hospitals after orthopedic ASC surgery for a diverse array of reasons. However, potentially preventable causes, such as urinary retention, pain, nausea, vomiting, syncope, and other surgery-related complications, were common diagnoses associated with unplanned hospital visits across the AHRQ clinical categories included in the measure cohort (Table 4).

4.2 Patient-Level Risk-Adjustment Model

4.2.1 *Candidate and Final Variables*

Candidate variables for risk adjustment included patient demographics, clinical comorbidities, and procedure characteristics (see Appendix D, Table D1). After performing the stepwise, purposeful variable selection procedure described in Section 3.5.3 above, the final risk-adjustment model included age, 27 comorbidities, and a variable (work RVUs) to adjust for surgical procedural complexity (see Table 1). Table 1 shows the frequency of the final risk-adjustment variables in the Development and Validation Samples.

4.2.2 *Model Performance and Validation*

As the results in Table 5 show, the c-statistic for the final model in the Development Sample was 0.662, which indicated moderate model discrimination; the c-statistic in the Validation Sample was slightly higher (0.665). It should be noted that our goal is not to maximize prediction but rather to make fair comparisons across ASC facilities. Risk models designed to predict hospital visits rather than to adjust for differences unrelated to quality would likely have higher c-statistics, as they would typically adjust for variables such as complications of the procedure. We intentionally do not adjust for such variables. Additionally, the risk decile plots showed good calibration; the model performed well in each of the risk deciles in both the Development Sample (Figure 2) and the Validation Sample (Figure 3). The mean predicted unplanned hospital visit rate in the Development Sample ranged from 0.98% in the lowest decile of predicted orthopedic surgery hospital visit rate to 6.20% in the highest predicted risk decile, a range of 5.22%; comparable results were found in the Validation Sample (Table 5).

The regression coefficients of the model variables were also stable across the Development and Validation Samples (Table 6).

4.3 ASC-Level Measure Score

4.3.1 *ASC-Level Measure Score Variation*

Using the Medicare FFS FYs 2014-2015 Dataset, we found variation in the risk-standardized measure score among ASCs (Figure 4). The median RSHVR was 2.5%, ranging from 1.8% to 3.8% (the 25th and 75th percentiles were 2.4% and 2.6%, respectively). The same distribution of RSHVRs was found for facilities with more patients. For ASCs with at least 250 cases, the median facility-level RSHVR was 2.5%, ranging from 1.8% to 3.8% (Figure 5).

Using a bootstrapped 95% interval estimate, we found 7 significant outliers among 2,734 ASCs. Of the 2,734 ASCs, 2 were categorized as better than expected, 5 as worse than expected, and 2,727 as no different than expected.

4.3.2 *ASC-Level Measure Score Reliability Testing*

The overall ICC [2,1] was 0.226. Although this value indicates fair measure score reliability, it is lower than typically seen for other claims-based quality measures developed by CORE. As we would expect, the ICC [2,1] increased for ASCs with more patients. For ASCs with at least 250 cases in each of the two samples, the ICC [2,1] was 0.359, which reflects better reliability that is more consistent with previously developed measures. In the 4-year data set, of the 3,075 ASCs, 467 (15.2%) had 250 or more procedures, accounting for 57.3% of all procedures in the measure cohort.

CMS is planning to use 2 years of data for measure calculation and to publicly report measure scores for only high-volume facilities. We expect that smaller ASCs will still benefit from seeing their measure results and individual patient-level outcomes, as these data are currently largely unknown to ASCs and providers.

4.3.3 *ASC-Level Measure Score Disparities Testing*

The ASC-level risk-standardized scores were highly correlated (Spearman correlation coefficients of nearly 1.0) when calculated with and without the addition of the three SES variables (Medicaid dual-eligibility status, African-American race, and the AHRQ SES index).

In addition, the analyses of ASCs categorized into quartiles based on proportions of Medicare-Medicaid dual-eligible patients, of African-American patients, and of low-SES patients (as identified by the ARHQ SES index) showed limited differences in the distributions of the RSHVRs by quartile. Also, the differences in the median rates were the same for all three variables (Table 7).

4.3.4 *Face Validity Testing*

A total of 13 of the 14 TEP members responded to the survey of face validity. Of the 13 respondents:

- 12 TEP members indicated that they agreed (6 strongly agreed, 5 moderately agreed, and 1 somewhat agreed), while 1 TEP member moderately disagreed, with the following statement: “The risk-standardized hospital visit rates obtained from the ‘Hospital Visits after Orthopedic Ambulatory Surgical Center Procedures’ measure as specified are valid and useful measures of ASC orthopedic surgical quality of care.” Of the 12 TEP members

who agreed, 6 strongly agreed, 5 moderately agreed, and 1 somewhat agreed with the statement.

- 12 TEP members indicated that they agreed (6 strongly agreed, 5 moderately agreed, and 1 somewhat agreed), while 1 TEP member moderately disagreed, with the following statement: "The risk-standardized hospital visit rates obtained from the 'Hospital Visits after Orthopedic Ambulatory Surgical Center Procedures' measure as specified will provide ASCs with information that can be used to improve their quality of care."

These validity testing results demonstrate TEP agreement with the overall face validity of the measure. (Note: One TEP member was not polled as she only participated in the early stages of measure development.)

5. Summary and Discussion

Medicare beneficiaries commonly undergo orthopedic procedures at ASCs. Based on our empiric analyses of Medicare FFS patients aged 65 years and older, from October 1, 2014, through September 30, 2015, 2,523 ASCs performed 186,806 outpatient orthopedic surgeries of the types included in this measure; 1,402 ASCs had at least 30 cases. Our analysis showed that 2.5% of orthopedic surgical procedures at ASCs among Medicare FFS patients aged 65 years and older are followed by unplanned hospital visits within 7 days. Hospital visits often occur due to potentially preventable adverse events, such as urinary retention, bleeding, postoperative pain, and nausea and vomiting. Our results also showed variation in unplanned hospital visits among ASCs after adjusting for case mix, which suggests variation in quality of care.

The many small-volume ASCs make development and use of outcome measures to assess quality of care challenging. ASCs with few cases in a given year limit our ability to estimate risk-adjusted ASC-level measure scores, thereby limiting CMS's ability to assess quality. To expand the number of cases available for estimating rates across facilities and to increase the reliability of the measure score, CMS is planning to use 2 years of data for public reporting.

In summary, hospital visits following orthopedic procedures performed at ASCs are unexpected by patients, currently largely invisible to providers, and costly to the healthcare system. The orthopedic ASC measure, as specified, has the potential to illuminate these differences in quality, inform patient choice, drive quality improvement, and enhance care coordination, with the ultimate goal of reducing unplanned hospital visits following orthopedic procedures performed at ASCs.

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7. Tables

Table 1. Frequency of risk model variables in the Medicare Development and Validation Samples

Variable (definition)	Development Sample 10/01/2014 – 09/30/2015		Validation Sample 10/01/2014 – 09/30/2015	
	#	%	#	%
N	132,865	70.0%	56,941	30.0%
Age: mean (standard deviation [SD])	73.1	5.7	73.1	5.7
Work Relative Value Units (work RVUs): mean (SD)	7.9	3.8	7.9	3.8
Comorbidities				
Cancer (Condition Category [CC] 8, 9, 10, 11, 12, 13, 14)	30,850	23.2%	13,430	23.6%
Disorders of fluid/electrolyte/acid-base (CC 23, 24)	17,589	13.2%	7,513	13.2%
Other gastrointestinal disorders (CC 38)	65,564	49.4%	28,086	49.3%
Bone/joint/muscle infections/necrosis (CC 39)	4,203	3.2%	1,738	3.1%
Rheumatoid and osteoarthritis (CC 40, 41, 42)	71,823	54.1%	30,832	54.2%
Dementia (CC 51, 52, 53)	6,389	4.8%	2,633	4.6%
Psychiatric disorders (CC 57, 58, 59, 60, 61, 62, 63)	31,680	23.8%	13,392	23.5%
Multiple sclerosis (CC 77)	494	0.4%	191	0.3%
Seizure disorders and convulsions (CC 79)	2,084	1.6%	865	1.5%
Congestive heart failure (CC 85)	10,379	7.8%	4,551	8.0%
Ischemic heart disease (CC 86, 87, 88, 89)	29,771	22.4%	12,867	22.6%
Hypertension and hypertensive disease (CC 94, 95)	96,326	72.5%	41,331	72.6%
Stroke (CC 99, 100)	3,836	2.9%	1,635	2.9%
Vascular disease (CC 106, 107, 108, 109)	34,942	26.3%	14,766	25.9%
Chronic lung disease (CC 111, 112, 113)	25,157	18.9%	10,604	18.6%
Pneumonia (CC 114, 115, 116)	6,030	4.5%	2,584	4.5%
Other respiratory disorders (CC 118)	35,912	27.0%	12,867	22.6%
Chronic renal disease (CC 132, 133, 134, 135, 136, 137, 138, 139, 140)	14,811	11.2%	6,317	11.1%
Chronic ulcers (CC 157, 158, 159, 160, 161)	7,692	5.8%	3,261	5.7%
Head injury (CC 166, 167, 168)	6,030	3.5%	2,031	3.6%
Major traumatic fracture or internal injury (170, 171, 172)	7,148	5.4%	3,067	5.4%
Major symptoms, abnormalities (CC 178)	82,211	61.9%	35,260	61.9%
Minor symptoms, signs, findings (CC 179)	112,883	85.0%	28,328	84.9%

Variable (definition)	Development Sample 10/01/2014 – 09/30/2015		Validation Sample 10/01/2014 – 09/30/2015	
	#	%	#	%
Morbid obesity (ICD-9-CM codes 27801, V8541, V8542, V8543, V8544, V8545)	4,066	3.1%	1,727	3.0%
Opioid abuse (ICD-9 CM codes 30400, 30401, 30402, 30403, 30470, 30471, 30472, 30403, 30550, 30551, 30552, 30553)	897	0.7%	360	0.6%
Tobacco use disorder (ICD-9-CM diagnosis code 3051)	5,837	4.4%	2,394	4.2%
Chronic anticoagulant use (ICD-9-CM diagnosis code V5861)	8,983	6.8%	3,953	6.9%

Table 2. Top 20 procedures in the orthopedic cohort (data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

CPT® code	CPT® code short description	Number of procedures	% of all surgeries
26055	incise finger tendon sheath	20,849	11.0%
29827	arthroscopic rotator cuff repair	16,618	8.8%
29881	knee arthroscopy/surgery	15,852	8.4%
29880	knee arthroscopy/surgery	15,032	7.9%
28285	repair of hammertoe	8,445	4.5%
25447	repair wrist joints	6,094	3.2%
20680	removal of support implant	5,652	3.0%
26160	remove tendon sheath lesion	4,773	2.5%
23412	repair rotator cuff chronic	3,930	2.1%
28296	correction of bunion	3,825	2.0%
26123	release palm contracture	3,452	1.8%
29824	shoulder arthroscopy/surgery	2,643	1.4%
29879	knee arthroscopy/surgery	2,257	1.2%
25609	treat fx radial 3+ frag	2,201	1.2%
25000	incision of tendon sheath	2,147	1.1%
29876	knee arthroscopy/surgery	2,003	1.1%
29823	shoulder arthroscopy/surgery	1,895	1.0%
28292	correction of bunion	1,861	1.0%
28750	fusion of big toe joint	1,742	0.9%
28299	correction of bunion	1,565	0.8%

Table 3. Number and frequency of emergency department visits, observation stays, and unplanned inpatient admissions (data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

Outcome type	Number of orthopedic procedures with outcome	7-day unplanned visit rate
Hospital visits (emergency department visit, observation stay, or unplanned inpatient admission)	4,749	2.5%
Emergency department visit or observation stay visit	3,654	1.9%
Unplanned inpatient admission	1,095	0.6%

Table 4. Top hospital visit diagnoses for any hospital visit within 7 days of orthopedic procedures (data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
142 - Partial excision bone	11,106	315	2.8%	99859	Other postop infection	13
				99811	Hemorrhage complic proc	12
				78820	Retention urine NOS	12
				56400	Constipation NOS	10
				78701	Nausea with vomiting	10
				78609	Respiratory abnorm NEC	7
				0389	Septicemia NOS	7
				486	Pneumonia, organism NOS	6
				5990	Urin tract infection NOS	6
				7295	Pain in limb	5
143 - Bunionectomy or repair of toe deformities	19,163	336	1.8%	99859	Other postop infection	17
				33818	Acute postop pain NEC	16
				99811	Hemorrhage complic proc	16
				7802	Syncope and collapse	15
				78659	Chest pain NEC	11
				78701	Nausea with vomiting	11
				56400	Constipation NOS	9
				7295	Pain in limb	9
				4019	Hypertension NOS	8
				42731	Atrial fibrillation	8
145 - Treatment, fracture or dislocation of radius and ulna	6,026	215	3.6%	33818	Acute postop pain NEC	14
				56400	Constipation NOS	9
				V5489	Orthopedic aftercare NEC	8
				5990	Urin tract infection NOS	7

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
				81342	Fx distal radius NEC-cl	7
				486	Pneumonia, organism NOS	5
				49121	Obs chr bronc w(ac) exac	5
				79902	Hypoxemia	5
				42731	Atrial fibrillation	5
				78650	Chest pain NOS	4
146 - Treatment, fracture or dislocation of hip and femur	10	1	10.0%	99649	Mech com orth dev NEC	1
147 - Treatment, fracture or dislocation of lower extremity (other than hip or femur)	2,710	101	3.7%	33818	Acute postop pain NEC	9
				56400	Constipation NOS	4
				0389	Septicemia NOS	4
				7295	Pain in limb	3
				8248	Fx ankle NOS-closed	3
				79902	Hypoxemia	3
				71947	Joint pain-ankle	3
				78820	Retention urine NOS	3
				78659	Chest pain NEC	2
				53550	Gstr/ddnts NOS w/o hmrhg	2
148 - Other fracture and dislocation procedure	3,533	171	4.8%	56400	Constipation NOS	9
				33818	Acute postop pain NEC	6
				42731	Atrial fibrillation	5
				7242	Lumbago	5
				5990	Urin tract infection NOS	5
				8054	Fx lumbar vertebra-close	4
				8860	Amputation finger	4
				78650	Chest pain NOS	4

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
				7802	Syncope and collapse	3
				V5832	Attn removal of sutures	3
149 - Arthroscopy	250	7	2.8%	4010	Malignant hypertension	1
				33818	Acute postop pain NEC	1
				99811	Hemorrhage complic proc	1
				71945	Joint pain-pelvis	1
				71106	Pyogen arthritis-l/leg	1
				71946	Joint pain-l/leg	1
				72981	Swelling of limb	1
150 - Division of joint capsule, ligament or cartilage	1,350	26	1.9%	486	Pneumonia, organism NOS	2
				78499	Head & neck symptoms NEC	1
				78079	Malaise and fatigue NEC	1
				V5489	Orthopedic aftercare NEC	1
				56400	Constipation NOS	1
				78097	Altered mental status	1
				56211	Dvrtcli colon w/o hmrhg	1
				G8918		1
				71941	Joint pain-shlder	1
				9953	Allergy, unspecified	1
151 - Excision of semilunar cartilage of knee	31,049	684	2.2%	33818	Acute postop pain NEC	60
				71946	Joint pain-l/leg	39
				7295	Pain in limb	32
				99811	Hemorrhage complic proc	23
				78820	Retention urine NOS	20
				56400	Constipation NOS	20
				72981	Swelling of limb	15

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
				7823	Edema	15
				78650	Chest pain NOS	14
				78659	Chest pain NEC	14
152 - Arthroplasty knee	1,208	53	4.4%	99832	Disrup-external op wound	4
				33818	Acute postop pain NEC	4
				99811	Hemorrhage complic proc	2
				6826	Cellulitis of leg	2
				56400	Constipation NOS	2
				78820	Retention urine NOS	2
				78060	Fever NOS	2
				78701	Nausea with vomiting	2
				78652	Painful respiration	1
				78609	Respiratory abnorm NEC	1
153 - Hip replacement, total and partial	112	4	3.6%	99811	Hemorrhage complic proc	1
				7840	Headache	1
				33818	Acute postop pain NEC	1
				99739	Respiratory comp NEC	1
154 - Arthroplasty other than hip or knee	7,203	233	3.2%	33818	Acute postop pain NEC	25
				7295	Pain in limb	13
				99859	Other postop infection	12
				56400	Constipation NOS	9
				78701	Nausea with vomiting	8
				7802	Syncope and collapse	7
				72981	Swelling of limb	6
				6823	Cellulitis of arm	5
				78820	Retention urine NOS	4

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
				78609	Respiratory abnorm NEC	4
156 - Injections and aspirations of muscles, tendons, bursa, joints and soft tissue	1	0	0.0%	Not applicable (N/A) – no hospital visits	N/A	N/A
157 - Amputation of lower extremity	2,806	133	4.7%	99762	Infection amputat stump	10
				0389	Septicemia NOS	7
				99811	Hemorrhage complic proc	5
				99859	Other postop infection	5
				25080	DMII oth nt st uncntrld	5
				78079	Malaise and fatigue NEC	4
				78701	Nausea with vomiting	3
				41071	Subendo infarct, initial	3
				78097	Altered mental status	3
				33818	Acute postop pain NEC	3
158 - Spinal fusion	215	26	12.1%	33818	Acute postop pain NEC	4
				7231	Cervicalgia	2
				486	Pneumonia, organism NOS	2
				78820	Retention urine NOS	1
				42731	Atrial fibrillation	1
				7823	Edema	1
				5990	Urin tract infection NOS	1
				78701	Nausea with vomiting	1
				5601	Paralytic ileus	1
				79902	Hypoxemia	1
	422	19	4.5%	7823	Edema	1

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
159 - Other diagnostic procedures on musculoskeletal system				56400	Constipation NOS	1
				71947	Joint pain-ankle	1
				73004	Ac osteomyelitis-hand	1
				5849	Acute kidney failure NOS	1
				73314	Path fx neck of femur	1
				41071	Subendo infarct, initial	1
				7295	Pain in limb	1
				5570	Ac vasc insuff intestine	1
				99859	Other postop infection	1
160 - Other therapeutic procedures on muscles and tendons	73,114	1,688	2.3%	33818	Acute postop pain NEC	99
				78820	Retention urine NOS	72
				56400	Constipation NOS	57
				78701	Nausea with vomiting	40
				99811	Hemorrhage complic proc	39
				71941	Joint pain-shlder	38
				78650	Chest pain NOS	34
				78659	Chest pain NEC	34
				7295	Pain in limb	33
				7823	Edema	5
161 - Other OR therapeutic procedures on bone	7,776	157	2.0%	78650	Chest pain NOS	6
				99859	Other postop infection	6
				99811	Hemorrhage complic proc	5
				33818	Acute postop pain NEC	4
				43411	Crbl emblsm w infrct	3
				56400	Constipation NOS	3
				486	Pneumonia, organism NOS	3
				5589	Noninf gastroenterit NEC	3

AHRQ clinical category	Number of procedures in clinical category	Number of unplanned hospital visits	Rate of unplanned hospital visits (%)	Top 10 primary diagnoses at hospital	ICD-9-CM diagnosis description	Frequency of diagnosis
				42789	Cardiac dysrhythmias NEC	3
				78659	Chest pain NEC	3
162 - Other OR therapeutic procedures on joints	19,811	499	2.5%	33818	Acute postop pain NEC	26
				78650	Chest pain NOS	20
				99811	Hemorrhage complic proc	17
				7295	Pain in limb	16
				71946	Joint pain-l/leg	13
				56400	Constipation NOS	13
				78701	Nausea with vomiting	9
				78605	Shortness of breath	9
				42731	Atrial fibrillation	9
				78659	Chest pain NEC	8
163 - Other non-OR therapeutic procedures on musculoskeletal system	36	0	0.00%	N/A; no hospital visits	N/A	N/A
164 - Other OR therapeutic procedures on musculoskeletal system	1,905	81	4.3%	99811	Hemorrhage complic proc	9
				8860	Amputation finger	5
				8830	Open wound of finger	4
				00845	Int inf clstrdium dfcile	3
				33818	Acute postop pain NEC	3
				4019	Hypertension NOS	3
				99762	Infection amputat stump	2
				51881	Acute respiratry failure	2
				78609	Respiratory abnorm NEC	2
				42731	Atrial fibrillation	2

Table 5. Risk-adjustment model performance summaries in the Medicare Development and Validation Samples

Characteristic	Development Sample, 10/01/2014 – 09/30/2015	Validation Sample, 10/01/2014 – 09/30/2015
N	132,865	56,941
# of hospital visits in 7 days	3,327 (2.5%)	1,428 (2.5%)
Calibration (γ0, γ1)	(0, 1)	(-0.04, 0.99)
c-statistic	0.662	0.665
Predictive ability (lowest-highest risk decile)	0.98%-6.2%	0.96%-6.2%

Table 6. Model parameter estimates and odds ratios in the Medicare Development and Validation Samples

	Development Sample, 10/01/2014 – 09/30/2015		Validation Sample, 10/01/2014 – 09/30/2015	
	Estimate	**Odds Ratio (95% CI)**	**Estimate**	**Odds Ratio (95% CI)**
Intercept	-5.416		-5.475	
Age - Mean (SD)	0.027	1.03 (1.02-1.03)	0.033	1.03 (1.02-1.04)
Work Relative Value Unit - Mean (SD)	0.090	1.09 (1.09-1.10)	0.094	1.10 (1.08-1.11)
Comorbidities				
Cancer	-0.120	0.89 (0.82-0.96)	-0.049	0.95 (0.84-1.08)
Disorders of fluid/electrolyte/acid-base	0.107	1.11 (1.01-1.23)	0.181	1.20 (1.04-1.39)
Other gastrointestinal disorders	0.147	1.16 (1.07-1.25)	0.108	1.11 (0.99-1.25)
Bone/joint/muscle infections/necrosis	0.356	1.43 (1.21-1.69)	0.462	1.59 (1.23-2.05)
Rheumatoid and osteoarthritis	0.079	1.08 (1.01-1.16)	0.107	1.11 (1.00-1.24)
Dementia	0.148	1.16 (1.01-1.33)	0.156	1.17 (0.95-1.44)
Psychiatric disorders	0.163	1.18 (1.09-1.27)	0.122	1.13 (1.00-1.28)
Multiple sclerosis	0.533	1.70 (1.11-2.61)	0.303	1.35 (0.63-2.91)
Seizure disorders and convulsions	0.296	1.34 (1.08-1.67)	0.313	1.37 (0.97-1.92)
Congestive heart failure	0.167	1.18 (1.05-1.32)	0.232	1.26 (1.06-1.50)
Ischemic heart disease	0.086	1.09 (1.00-1.18)	0.118	1.13 (0.99-1.28)
Hypertension and hypertensive disease	0.109	1.12 (1.02-1.22)	0.061	1.06 (0.93-1.22)
Stroke	0.193	1.21 (1.03-1.43)	0.016	1.02 (0.77-1.33)
Vascular disease	0.133	1.14 (1.05-1.24)	0.087	1.09 (0.96-1.23)
Chronic lung disease	0.116	1.12 (1.03-1.22)	0.186	1.20 (1.06-1.37)
Pneumonia	0.192	1.21 (1.06-1.39)	0.164	1.18 (0.96-1.45)
Other respiratory disorders	0.082	1.09 (1.00-1.18)	0.120	1.13 (1.00-1.27)
Chronic renal disease	0.131	1.14 (1.03-1.26)	0.034	1.04 (0.88-1.21)
Chronic ulcers	0.229	1.26 (1.10-1.44)	0.155	1.17 (0.94-1.45)
Head injury	0.223	1.25 (1.08-1.45)	0.129	1.14 (0.90-1.44)
Major traumatic fracture or internal injury	0.192	1.21 (1.06-1.38)	0.168	1.18 (0.97-1.45)
Major symptoms, abnormalities	0.085	1.09 (1.00-1.19)	0.128	1.14 (1.00-1.29)
Minor symptoms, signs, findings	0.209	1.23 (1.09-1.39)	0.200	1.22 (1.02-1.47)

	Development Sample, 10/01/2014 – 09/30/2015		Validation Sample, 10/01/2014 – 09/30/2015	
	Estimate	Odds Ratio (95% CI)	Estimate	Odds Ratio (95% CI)
Morbid obesity	-0.076	0.93 (0.76-1.12)	0.047	1.05 (0.79-1.39)
Opioid abuse	0.339	1.40 (1.02-1.92)	0.382	1.47 (0.90-2.39)
Tobacco use	0.169	1.18 (1.02-1.38)	-0.041	0.96 (0.74-1.24)
Chronic anticoagulant use	0.316	1.37 (1.22-1.54)	0.166	1.18 (0.99-1.41)

Table 7. Variation in RSHVRs across ASCs by proportion of Medicaid dual-eligible, African-American, and low-SES patients (data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

	Medicaid dual-eligible status		African-American race		Low-SES	
	Low % (≤1.6%)	High % (≥6.1%)	Low % (0.0%)	High % (≥5.4%)	Low % (≤4.1%)	High % (≥16.0%)
Number of ASCs	351	348	368	347	350	351
Number of patients	43,040	32,232	41,203	30,722	44,511	42,988
Maximum RSHVR	3.4%	3.5%	3.4%	3.5%	3.3%	3.5%
90th	2.7%	2.8%	2.8%	2.8%	2.8%	2.7%
75th	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%
Median	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
25th	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%
10th	2.3%	2.4%	2.4%	2.3%	2.3%	2.3%
Minimum RSHVR	2.1%	2.1%	2.2%	2.1%	1.9%	2.1%

8. Figures

Figure 1. Timing of hospital visits within 30 days of orthopedic ASC procedures (event rate per day post-discharge for 0- through 30-day period; data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

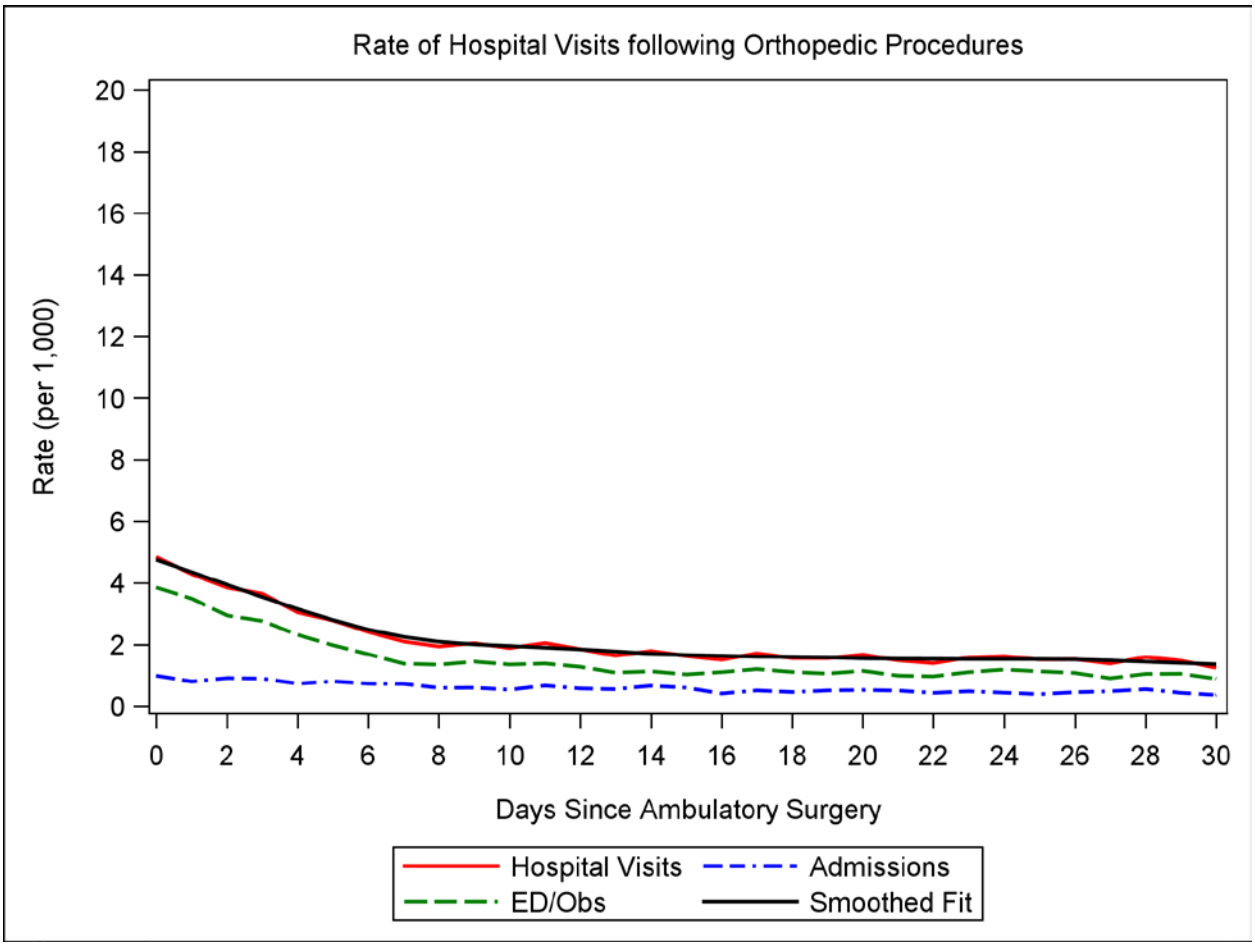


Figure 2. Calibration plot of predicted versus observed outcomes across deciles of patient risk in the Development Sample (data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

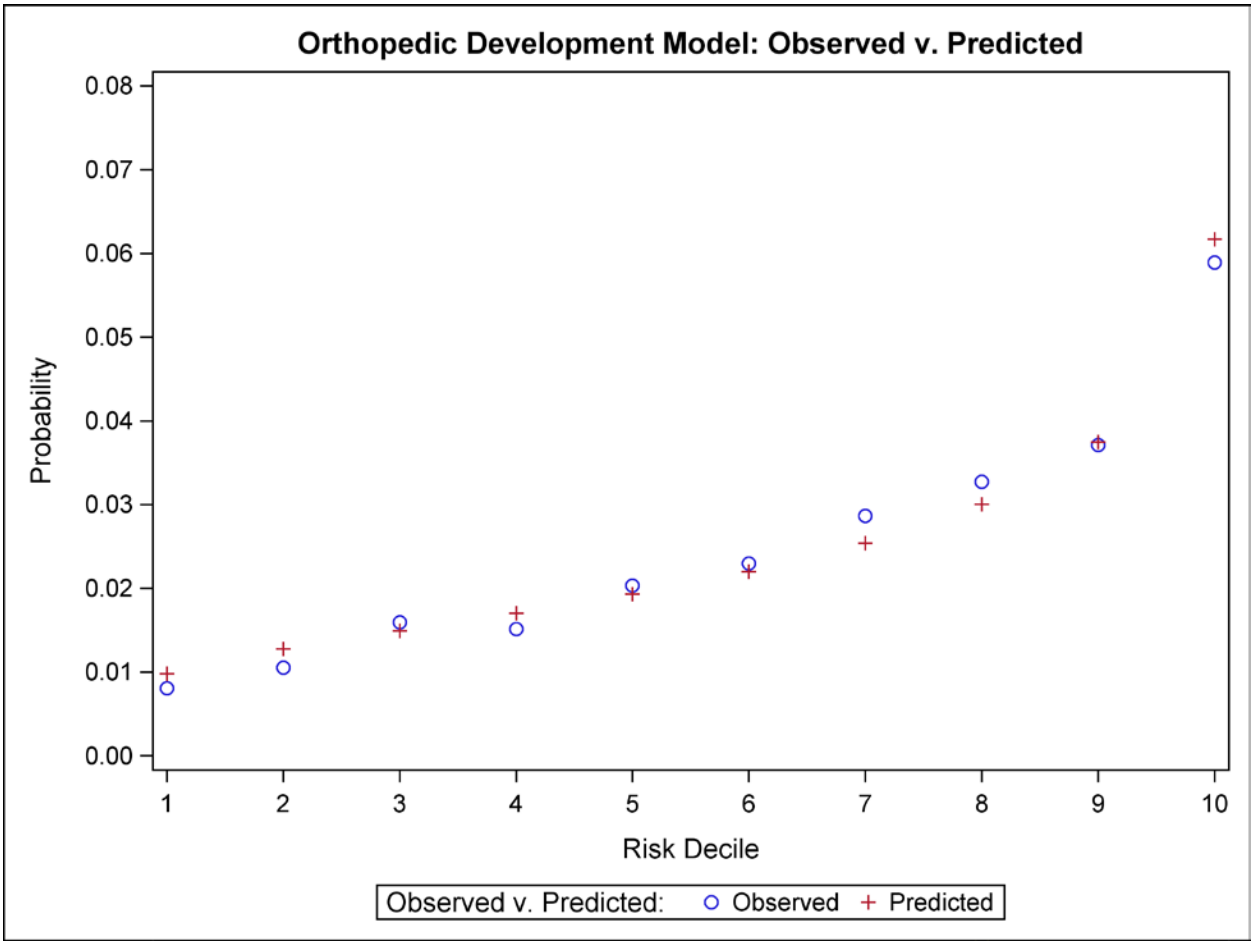


Figure 3. Calibration plot of predicted versus observed outcomes across deciles of patient risk in the Validation Sample (data source: Medicare FFS FY 2015 Dataset, 10/01/2014 – 09/30/2015)

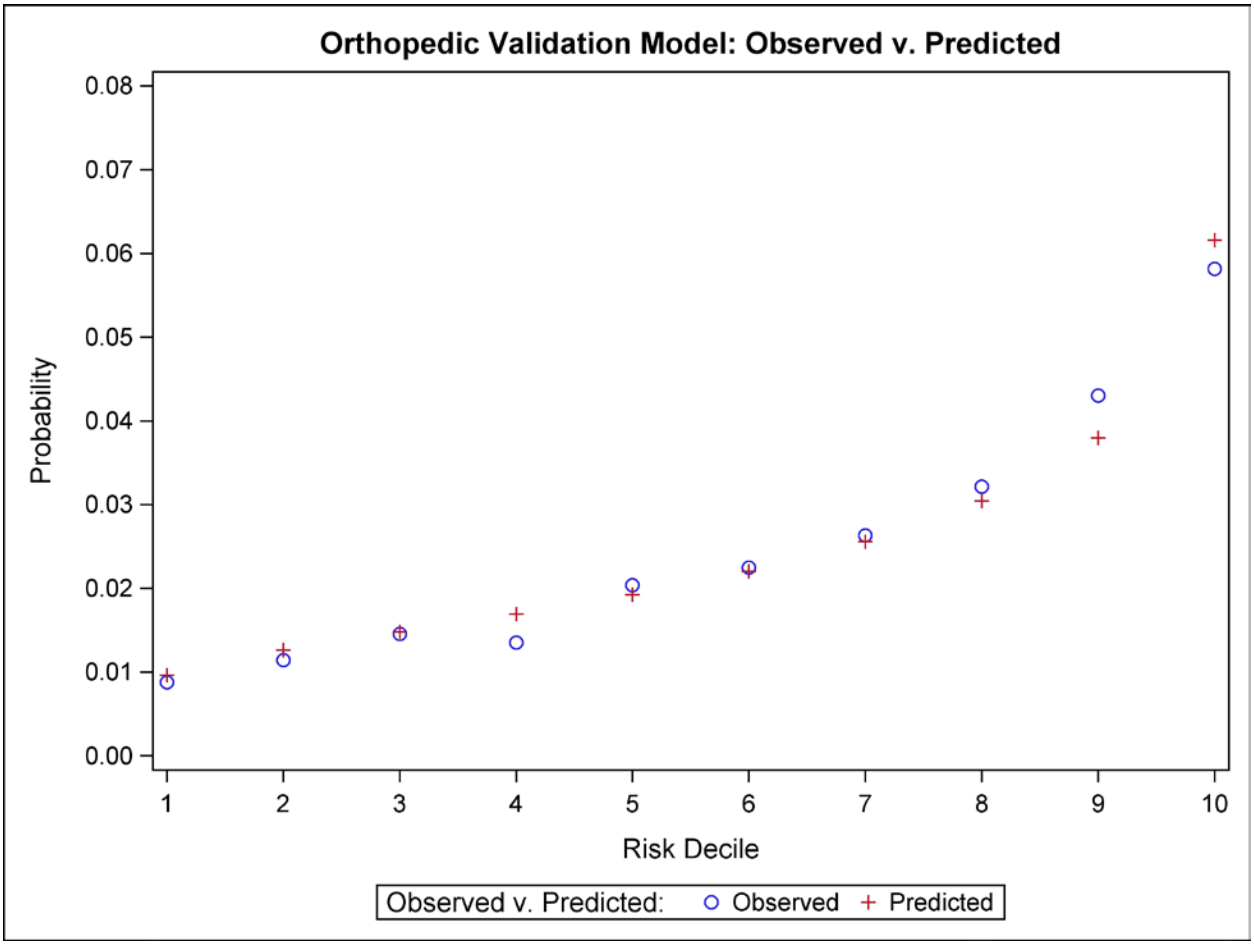


Figure 4. Distribution of risk-adjusted hospital visit rates following orthopedic ASC procedures (data source: Medicare FFS FYs 2014-2015 Dataset, 10/01/2013 – 09/30/2015)

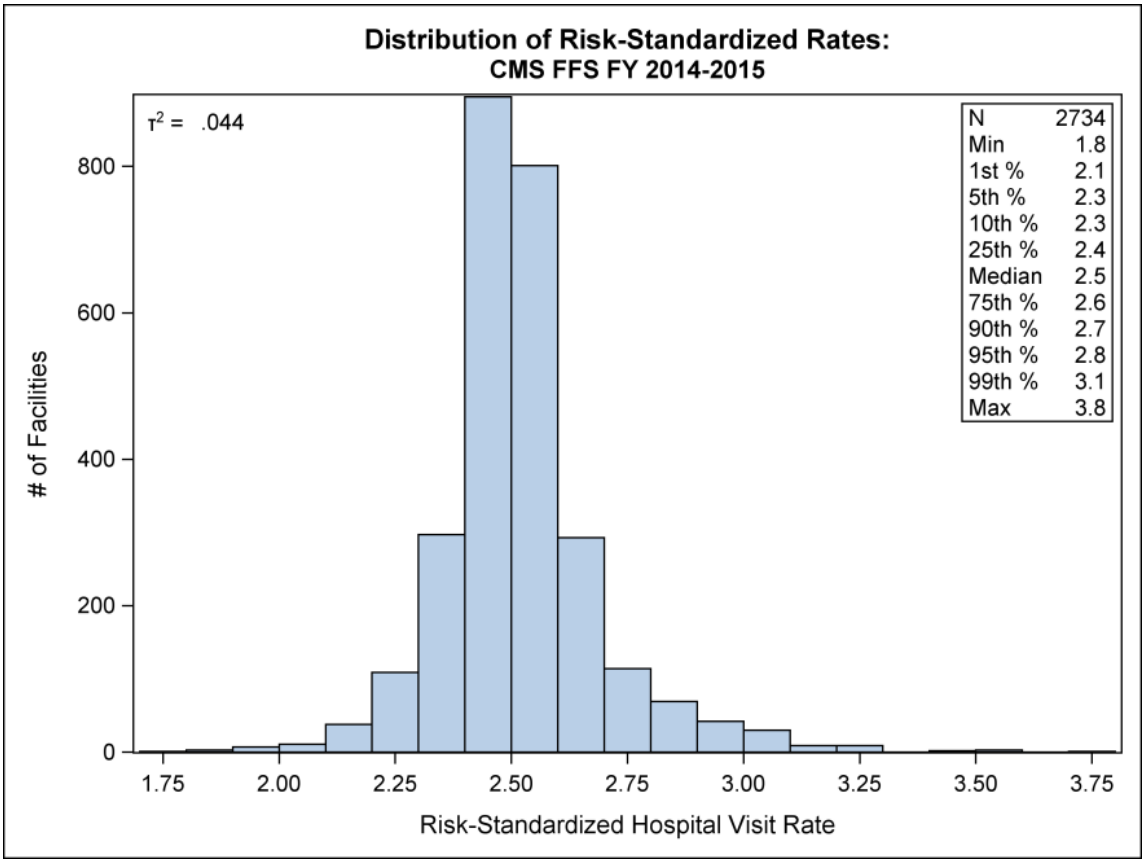
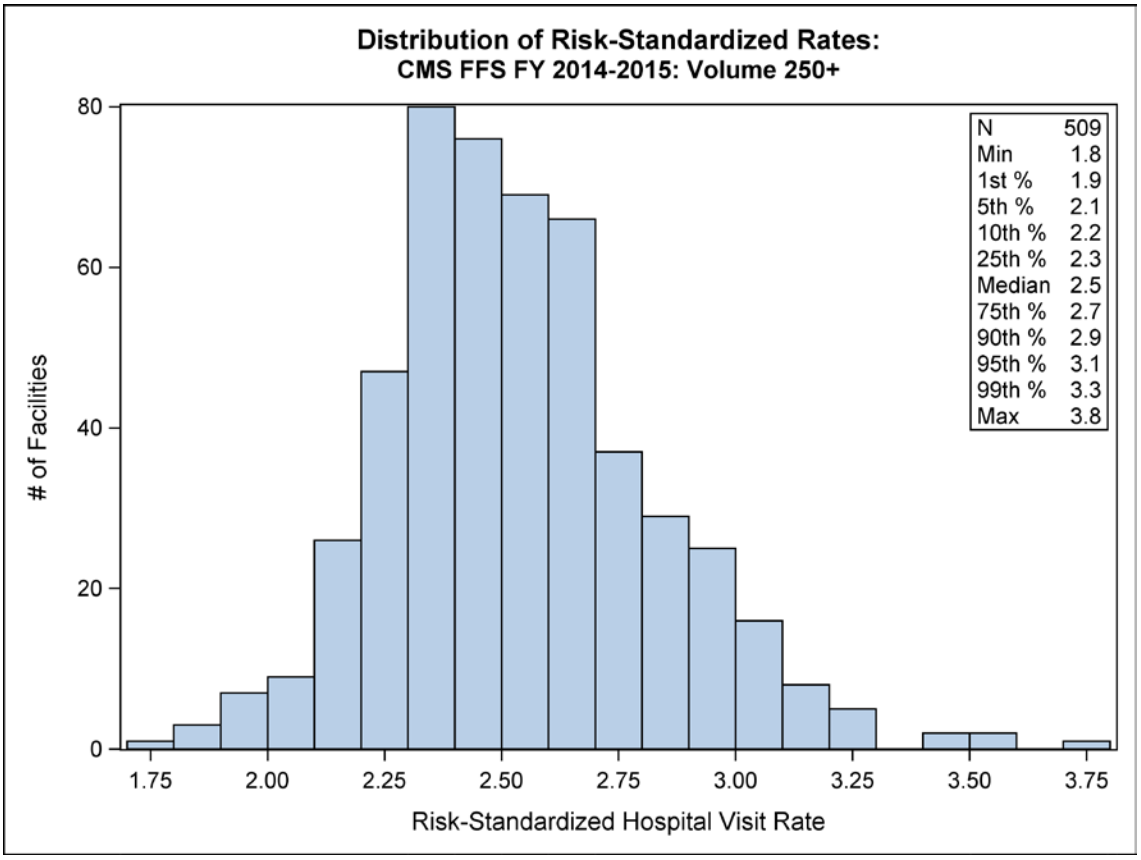


Figure 5. Distribution of risk-adjusted hospital visit rates following orthopedic ASC procedures for facilities with at least 250 cases (data source: Medicare FFS FYs 2014-2015 Dataset, 10/01/2013 – 09/30/2015)



Appendices

Appendix A: Emergency Department Visits and Observation Stays Definition

Table A1. HCPCS codes or revenue center codes that define emergency department visits and observation stays

Billing (HCPCS) or Revenue Code[2]	Description
0450	Emergency room
0451	Emergency room: EM/EMTALA
0452	Emergency room: ER/Beyond EMTALA
0456	Emergency room: urgent care
0459	Emergency room: other emergency room
0981	Professional fees (096x) emergency room
0762	Observation room
G0378[3]	Hospital observation service, per hour

[2] Identified in Medicare Part B Outpatient hospital claims.

[3] Denotes HCPCS Codes, all other codes are revenue center codes.

Appendix B: Planned Admission Algorithm

B1. Planned Admission Algorithm Overview

The planned admission algorithm is adapted from the CMS Planned Readmission Algorithm Version 4.0. The algorithm is a set of criteria for classifying hospital inpatient admissions occurring after an orthopedic ASC surgery as planned or unplanned using Medicare claims. CMS seeks to count only unplanned admissions in the measure outcome because variation in planned admissions does not reflect quality differences. CORE developed the Planned Readmission Algorithm under contract to CMS based on a hospital-wide (not condition-specific) cohort of patients.[36]

The algorithm classifies admissions as planned or unplanned using a flow chart (Figure PA1) and four tables of procedures and conditions (Table PA1–Table PA4). Table PA1 identifies procedures that, if present in an admission, classify the admission as planned. Table PA2 identifies principal discharge diagnoses that classify admissions as planned. Table PA3 identifies procedures that, if present, classify an admission as planned as long as that admission does not have an acute (unplanned) principal discharge diagnosis. Table PA4 lists the acute (unplanned) principal discharge diagnoses that disqualify admissions with a potentially planned procedure in Table PA3 as planned.

The algorithm uses the Agency for Healthcare Research and Quality's (AHRQ's) Clinical Classifications Software (CCS) (http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp) codes to group thousands of individual procedure and diagnosis ICD-9-CM codes into clinically coherent, mutually exclusive procedure CCS categories and mutually exclusive diagnosis CCS categories, respectively.

B2. Detailed Description of Planned Readmission Algorithm Version 4.0 Adapted for Orthopedic ASC Measure

The planned admission algorithm uses the flow chart (Figure PA1) and Table PA1–Table PA4, adapted for the orthopedic ASC procedure population, to identify specific procedure categories and discharge diagnosis categories to classify admissions as planned or unplanned. As illustrated in the flow chart (Figure PA1), admissions that include certain procedures (Table PA1) or are for certain diagnoses Table PA2 are always considered planned. If the admission does not include a procedure or diagnosis in Table PA1 or Table PA2 that is always considered planned, the algorithm checks whether the admission has at least 1 procedure that is considered potentially planned (Table PA3). If the admission has no procedures from Table PA3, the admission is considered unplanned. Table PA3 includes AHRQ procedure CCS categories and

individual ICD-9-CM procedure codes. Examples of potentially planned procedures are total hip replacement (Procedure CCS 153) and hernia repair (Procedure CCS 85).

If the admission has at least one potentially planned procedure from Table PA3, the algorithm checks for a principal discharge diagnosis that is considered acute (Table PA4). If the admission has an acute principal discharge diagnosis from Table PA4, the admission is considered unplanned. Otherwise, it is considered planned. The list of acute principal discharge diagnoses includes diagnosis groups from AHRQ condition categories and groupings of individual ICD-9-CM diagnosis codes that represent cardiac diagnoses that would not be associated with a planned admission. Examples of acute principal discharge diagnoses that identify admissions with potentially planned procedures as unplanned are pneumonia (Diagnosis CCS 122) and cardiac arrest (Diagnosis CCS 107).

Figure PA1. Planned admission algorithm flowchart

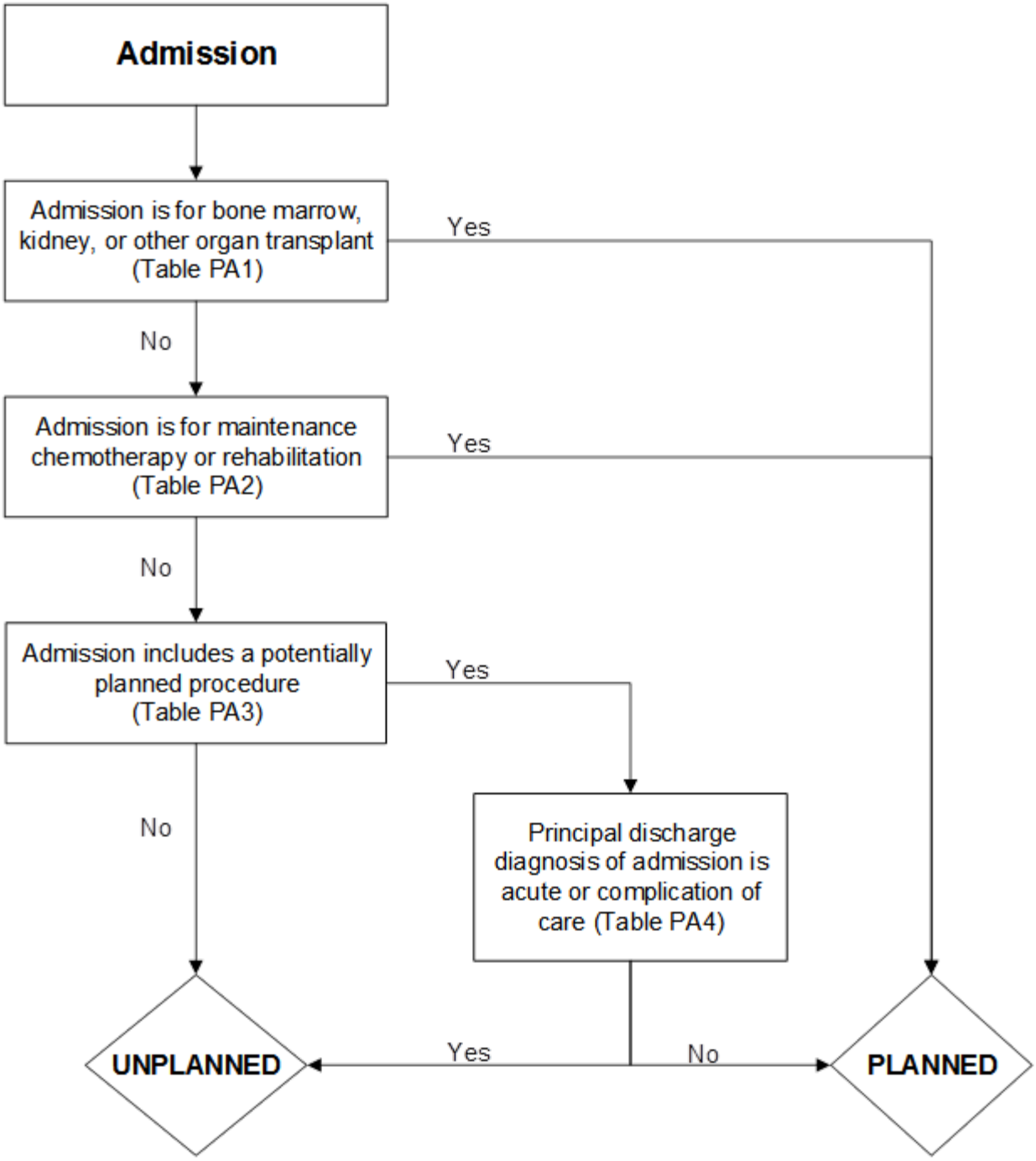


Table PA1. Procedure categories that are always planned (Planned Readmission Algorithm Version 4.0 – adapted for orthopedic ASC measure Version 1.0)

Procedure CCS (ICD-9-CM & ICD-10-CM)	Description
64	Bone marrow transplant
105	Kidney transplant
176	Other organ transplantation (in ICD-10-CM version, description adds: "[other than bone marrow corneal or kidney]")

Table PA2. Diagnosis categories that are always planned (Planned Readmission Algorithm Version 4.0 – adapted for orthopedic ASC measure Version 1.0)

Diagnosis CCS (ICD-9-CM & ICD-10-CM)	Description
45	Maintenance chemotherapy
254	Rehabilitation

Table PA3. Procedure categories that are potentially planned (Planned Readmission Algorithm Version 4.0 – adapted for orthopedic ASC measure Version 1.0)

Code	Description
Procedure CCS (ICD-9-CM & ICD-10-CM)	
1	Incision and excision of central nervous system (CNS)
3	Laminectomy; excision intervertebral disc (in ICD-10-CM version, description is: "excision, destruction or resection of intervertebral disc")
5	Insertion of catheter or spinal stimulator and injection into spinal canal
9	Other OR therapeutic nervous system procedures
10	Thyroidectomy; partial or complete
12	Other therapeutic endocrine procedures (in ICD-10-CM version, description is: "therapeutic endocrine procedures")
33	Other OR therapeutic procedures on nose; mouth and pharynx
36	Lobectomy or pneumonectomy
38	Other diagnostic procedures on lung and bronchus
40	Other diagnostic procedures of respiratory tract and mediastinum
43	Heart valve procedures
44	Coronary artery bypass graft (CABG)
45	Percutaneous transluminal coronary angioplasty (PTCA) (in ICD-10-CM version, description adds: "with or without stent")
49	Other OR heart procedures
51	Endarterectomy; vessel of head and neck
52	Aortic resection; replacement or anastomosis

Code	Description
53	Varicose vein stripping; lower limb
55	Peripheral vascular bypass
56	Other vascular bypass and shunt; not heart
59	Other OR procedures on vessels of head and neck
66	Procedures on spleen
67	Other therapeutic procedures; hemic and lymphatic system
74	Gastrectomy; partial and total
78	Colorectal resection
79	Local excision of large intestine lesion (not endoscopic)
84	Cholecystectomy and common duct exploration
85	Inguinal and femoral hernia repair
86	Other hernia repair
99	Other OR gastrointestinal therapeutic procedures
104	Nephrectomy; partial or complete
106	Genitourinary incontinence procedures
107	Extracorporeal lithotripsy; urinary
109	Procedures on the urethra
112	Other OR therapeutic procedures of urinary tract
113	Transurethral resection of prostate (TURP)
114	Open prostatectomy
119	Oophorectomy; unilateral and bilateral
120	Other operations on ovary
124	Hysterectomy; abdominal and vaginal
129	Repair of cystocele and rectocele; obliteration of vaginal vault
132	Other OR therapeutic procedures; female organs
142	Partial excision bone
152	Arthroplasty knee
153	Hip replacement; total and partial
154	Arthroplasty other than hip or knee
158	Spinal fusion
159	Other diagnostic procedures on musculoskeletal system
166	Lumpectomy; quadrantectomy of breast
167	Mastectomy
170 (only in ICD-9-CM version of algorithm)	Excision of skin lesion
172	Skin graft

Code	Description
175 (only in ICD-10-CM version of algorithm)	Other OR therapeutic procedures on skin subcutaneous tissue fascia and breast
ICD-9-PCS Code	
30.1	Hemilaryngectomy
30.29	Other partial laryngectomy
30.3	Complete laryngectomy
30.4	Radical laryngectomy
31.74	Revision of tracheostomy
34.6	Scarification of pleura
38.18	Endarterectomy, lower limb arteries
55.03	Percutaneous nephrostomy without fragmentation
55.04	Percutaneous nephrostomy with fragmentation
94.26	Subconvulsive electroshock therapy
94.27	Other electroshock therapy
ICD-10-PCS Code	
0CBS0ZZ	Excision of larynx, open approach
0CBS3ZZ	Excision of larynx, percutaneous approach
0CBS4ZZ	Excision of larynx, percutaneous endoscopic approach
0CBS7ZZ	Excision of larynx, via natural or artificial opening
0CBS8ZZ	Excision of larynx, via natural or artificial opening endoscopic
0CBS0ZZ	Excision of larynx, open approach
0CBS3ZZ	Excision of larynx, percutaneous approach
0CBS4ZZ	Excision of larynx, percutaneous endoscopic approach
0B110F4	Bypass trachea to cutaneous with tracheostomy device, open approach
0B110Z4	Bypass trachea to cutaneous with, open approach
0B113F4	Bypass trachea to cutaneous with tracheostomy device, percutaneous approach
0B113Z4	Bypass trachea to cutaneous, percutaneous approach
0B114F4	Bypass trachea to cutaneous with tracheostomy device, percutaneous endoscopic approach
0B114Z4	Bypass trachea to cutaneous, percutaneous endoscopic approach
0CTS0ZZ	Resection of larynx, open approach
0CTS4ZZ	Resection of larynx, percutaneous endoscopic approach
0CTS7ZZ	Resection of larynx, via natural or artificial opening
0CTS8ZZ	Resection of larynx, via natural or artificial opening endoscopic
0GTG0ZZ	Resection of left thyroid gland lobe, open approach
0GTG4ZZ	Resection of left thyroid gland lobe, percutaneous endoscopic approach

Code	Description
0GTH0ZZ	Resection of right thyroid gland lobe, open approach
0GTH4ZZ	Resection of right thyroid gland lobe, percutaneous endoscopic approach
0GTK0ZZ	Resection of thyroid gland, open approach
0GTK4ZZ	Resection of thyroid gland, percutaneous endoscopic approach
0WB60ZZ	Excision of neck, open approach
0WB63ZZ	Excision of neck, percutaneous approach
0WB64ZZ	Excision of neck, percutaneous endoscopic approach
0WB6XZZ	Excision of neck, external approach
0BW10FZ	Revision of tracheostomy device in trachea, open approach
0BW13FZ	Revision of tracheostomy device in trachea, percutaneous approach
0BW14FZ	Revision of tracheostomy device in trachea, percutaneous endoscopic approach
0WB6XZ2	Excision of neck, stoma, external approach
0WQ6XZ2	Repair neck, stoma, external approach
0B5N0ZZ	Destruction of right pleura, open approach
0B5N3ZZ	Destruction of right pleura, percutaneous approach
0B5N4ZZ	Destruction of right pleura, percutaneous endoscopic approach
0B5P0ZZ	Destruction of left pleura, open approach
0B5P3ZZ	Destruction of left pleura, percutaneous approach
0B5P4ZZ	Destruction of left pleura, percutaneous endoscopic approach
04CK0ZZ	Extirpation of matter from right femoral artery, open approach
04CK3ZZ	Extirpation of matter from right femoral artery, percutaneous approach
04CK4ZZ	Extirpation of matter from right femoral artery, percutaneous endoscopic approach
04CL0ZZ	Extirpation of matter from left femoral artery, open approach
04CL3ZZ	Extirpation of matter from left femoral artery, percutaneous approach
04CL4ZZ	Extirpation of matter from left femoral artery, percutaneous endoscopic approach
04CM0ZZ	Extirpation of matter from right popliteal artery, open approach
04CM3ZZ	Extirpation of matter from right popliteal artery, percutaneous approach
04CM4ZZ	Extirpation of matter from right popliteal artery, percutaneous endoscopic approach
04CN0ZZ	Extirpation of matter from left popliteal artery, open approach
04CN3ZZ	Extirpation of matter from left popliteal artery, percutaneous approach
04CN4ZZ	Extirpation of matter from left popliteal artery, percutaneous endoscopic approach
04CP0ZZ	Extirpation of matter from right anterior tibial artery, open approach
04CP3ZZ	Extirpation of matter from right anterior tibial artery, percutaneous approach
04CP4ZZ	Extirpation of matter from right anterior tibial artery, percutaneous endoscopic approach
04CQ0ZZ	Extirpation of matter from left anterior tibial artery, open approach
04CQ3ZZ	Extirpation of matter from left anterior tibial artery, percutaneous approach

Code	Description
04CQ4ZZ	Extirpation of matter from left anterior tibial artery, percutaneous endoscopic approach
04CR0ZZ	Extirpation of matter from right posterior tibial artery, open approach
04CR3ZZ	Extirpation of matter from right posterior tibial artery, percutaneous approach
04CR4ZZ	Extirpation of matter from right posterior tibial artery, percutaneous endoscopic approach
04CS0ZZ	Extirpation of matter from left posterior tibial artery, open approach
04CS3ZZ	Extirpation of matter from left posterior tibial artery, percutaneous approach
04CS4ZZ	Extirpation of matter from left posterior tibial artery, percutaneous endoscopic approach
04CT0ZZ	Extirpation of matter from right peroneal artery, open approach
04CT3ZZ	Extirpation of matter from right peroneal artery, percutaneous approach
04CT4ZZ	Extirpation of matter from right peroneal artery, percutaneous endoscopic approach
04CU0ZZ	Extirpation of matter from left peroneal artery, open approach
04CU3ZZ	Extirpation of matter from left peroneal artery, percutaneous approach
04CU4ZZ	Extirpation of matter from left peroneal artery, percutaneous endoscopic approach
04CV0ZZ	Extirpation of matter from right foot artery, open approach
04CV3ZZ	Extirpation of matter from right foot artery, percutaneous approach
04CV4ZZ	Extirpation of matter from right foot artery, percutaneous endoscopic approach
04CW0ZZ	Extirpation of matter from left foot artery, open approach
04CW3ZZ	Extirpation of matter from left foot artery, percutaneous approach
04CW4ZZ	Extirpation of matter from left foot artery, percutaneous endoscopic approach
04CY0ZZ	Extirpation of matter from lower artery, open approach
04CY3ZZ	Extirpation of matter from lower artery, percutaneous approach
04CY4ZZ	Extirpation of matter from lower artery, percutaneous endoscopic approach
0T9030Z	Drainage of right kidney with drainage device, percutaneous approach
0T9040Z	Drainage of right kidney with drainage device, percutaneous endoscopic approach
0T9130Z	Drainage of left kidney with drainage device, percutaneous approach
0T9140Z	Drainage of left kidney with drainage device, percutaneous endoscopic approach
0TC03ZZ	Extirpation of matter from right kidney, percutaneous approach
0TC04ZZ	Extirpation of matter from right kidney, percutaneous endoscopic approach
0TC13ZZ	Extirpation of matter from left kidney, percutaneous approach
0TC14ZZ	Extirpation of matter from left kidney, percutaneous endoscopic approach
0TF33ZZ	Fragmentation in right kidney pelvis, percutaneous approach
0TF34ZZ	Fragmentation in right kidney pelvis, percutaneous endoscopic approach
0TF43ZZ	Fragmentation in left kidney pelvis, percutaneous approach
0TF44ZZ	Fragmentation in left kidney pelvis, percutaneous endoscopic approach
GZB4ZZZ	Other electroconvulsive therapy

Code	Description
GZB0ZZZ	Electroconvulsive therapy, unilateral-single seizure
GZB1ZZZ	Electroconvulsive therapy, unilateral-multiple seizure
GZB2ZZZ	Electroconvulsive therapy, bilateral-single seizure
GZB3ZZZ	Electroconvulsive therapy, bilateral-multiple seizure
GZB4ZZZ	Other electroconvulsive therapy

Table PA4. Diagnosis categories that are acute (Planned Readmission Algorithm Version 4.0 – adapted for orthopedic ASC measure Version 1.0)

Code	Description
Diagnosis CCS (ICD-9-CM & ICD-10-CM)	
1	Tuberculosis
2	Septicemia (except in labor)
3	Bacterial infection; unspecified site
4	Mycoses
5	HIV infection
7	Viral infection
8	Other infections; including parasitic
9	Sexually transmitted infections (not HIV or hepatitis)
54	Gout and other crystal arthropathies
55	Fluid and electrolyte disorders
60	Acute posthemorrhagic anemia
61	Sickle cell anemia
63	Diseases of white blood cells
76	Meningitis (except that caused by tuberculosis or sexually transmitted disease)
77	Encephalitis (except that caused by tuberculosis or sexually transmitted disease)
78	Other CNS infection and poliomyelitis
82	Paralysis
83	Epilepsy; convulsions
84	Headache; including migraine
85	Coma; stupor; and brain damage
87	Retinal detachments; defects; vascular occlusion; and retinopathy
89	Blindness and vision defects
90	Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease)
91	Other eye disorders
92	Otitis media and related conditions
93	Conditions associated with dizziness or vertigo

Code	Description
99	Hypertension with complications and secondary hypertension
100	Acute myocardial infarction (with the exception of ICD-9-CM codes 410.x2)
102	Nonspecific chest pain
104	Other and ill-defined heart disease
107	Cardiac arrest and ventricular fibrillation
109	Acute cerebrovascular disease
112	Transient cerebral ischemia
116	Aortic and peripheral arterial embolism or thrombosis
118	Phlebitis; thrombophlebitis and thromboembolism
120	Hemorrhoids
122	Pneumonia (except that caused by TB or sexually transmitted disease)
123	Influenza
124	Acute and chronic tonsillitis
125	Acute bronchitis
126	Other upper respiratory infections
127	Chronic obstructive pulmonary disease and bronchiectasis
128	Asthma
129	Aspiration pneumonitis; food/vomitus
130	Pleurisy; pneumothorax; pulmonary collapse
131	Respiratory failure; insufficiency; arrest (adult)
135	Intestinal infection
137	Diseases of mouth; excluding dental
139	Gastroduodenal ulcer (except hemorrhage)
140	Gastritis and duodenitis
142	Appendicitis and other appendiceal conditions
145	Intestinal obstruction without hernia
146	Diverticulosis and diverticulitis
148	Peritonitis and intestinal abscess
153	Gastrointestinal hemorrhage
154	Noninfectious gastroenteritis
157	Acute and unspecified renal failure
159	Urinary tract infections
165	Inflammatory conditions of male genital organs
168	Inflammatory diseases of female pelvic organs
172	Ovarian cyst
197	Skin and subcutaneous tissue infections
198	Other inflammatory condition of skin

Code	Description
225	Joint disorders and dislocations; trauma-related
226	Fracture of neck of femur (hip)
227	Spinal cord injury
228	Skull and face fractures
229	Fracture of upper limb
230	Fracture of lower limb
232	Sprains and strains
233	Intracranial injury
234	Crushing injury or internal injury
235	Open wounds of head; neck; and trunk
237	Complication of device; implant or graft
238	Complications of surgical procedures or medical care
239	Superficial injury; contusion
240	Burns
241	Poisoning by psychotropic agents
242	Poisoning by other medications and drugs
243	Poisoning by non-medicinal substances
244	Other injuries and conditions due to external causes
245	Syncope
246	Fever of unknown origin
247	Lymphadenitis
249	Shock
250	Nausea and vomiting
251	Abdominal pain
252	Malaise and fatigue
253	Allergic reactions
259	Residual codes; unclassified
650	Adjustment disorders
651	Anxiety disorders
652	Attention-deficit, conduct, and disruptive behavior disorders (in ICD-10-CM version, description is: “attention-deficit”)
653	Delirium, dementia, and amnestic and other cognitive disorders (in ICD-10-CM version, description is: “delirium”)
656	Impulse control disorders, NEC (in ICD-10-CM version, description is: “impulse control disorders”)
658	Personality disorders
660	Alcohol-related disorders

Code	Description
661	Substance-related disorders
662	Suicide and intentional self-inflicted injury
663	Screening and history of mental health and substance abuse codes
670	Miscellaneous disorders
Acute ICD-9-CM codes within Diagnosis CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy	
3282	Diphtheritic myocarditis
3640	Meningococcal carditis NOS
3641	Meningococcal pericarditis
3642	Meningococcal endocarditis
3643	Meningococcal myocarditis
7420	Coxsackie carditis NOS
7421	Coxsackie pericarditis
7422	Coxsackie endocarditis
7423	Coxsackie myocarditis
11281	Candida endocarditis
11503	Histoplasma capsulatum pericarditis
11504	Histoplasma capsulatum endocarditis
11513	Histoplasma duboisii pericarditis
11514	Histoplasma duboisii endocarditis
11593	Histoplasmosis pericarditis
11594	Histoplasmosis endocarditis
1303	Toxoplasma myocarditis
3910	Acute rheumatic pericarditis
3911	Acute rheumatic endocarditis
3912	Acute rheumatic myocarditis
3918	Acute rheumatic heart disease NEC
3919	Acute rheumatic heart disease NOS
3920	Rheumatic chorea w heart involvement
3980	Rheumatic myocarditis
39890	Rheumatic heart disease NOS
39899	Rheumatic heart disease NEC
4200	Acute pericarditis in other disease
42090	Acute pericarditis NOS
42091	Acute idiopathic pericarditis
42099	Acute pericarditis NEC
4210	Acute/subacute bacterial endocarditis
4211	Acute endocarditis in other diseases

Code	Description
4219	Acute/subacute endocarditis NOS
4220	Acute myocarditis in other diseases
42290	Acute myocarditis NOS
42291	Idiopathic myocarditis
42292	Septic myocarditis
42293	Toxic myocarditis
42299	Acute myocarditis NEC
4230	Hemopericardium
4231	Adhesive pericarditis
4232	Constrictive pericarditis
4233	Cardiac tamponade
4290	Myocarditis NOS
Acute ICD-10-CM codes within Diagnosis CCS 97: Peri-; endo-; and myocarditis; cardiomyopathy	
A3681	Diphtheritic cardiomyopathy
A3950	Meningococcal carditis, unspecified
A3951	Meningococcal endocarditis
A3952	Meningococcal myocarditis
A3953	Meningococcal pericarditis
B3320	Viral carditis, unspecified
B3321	Viral endocarditis
B3322	Viral myocarditis
B3323	Viral pericarditis
B376	Candida endocarditis
B394	Histoplasmosis capsulati, unspecified
B395	Histoplasmosis duboisii
B399	Histoplasmosis, unspecified
B5881	Toxoplasma myocarditis
I010	Acute rheumatic pericarditis
I011	Acute rheumatic endocarditis
I012	Acute rheumatic myocarditis
I018	Other acute rheumatic heart disease
I019	Acute rheumatic heart disease, unspecified
I020	Rheumatic chorea with heart involvement
I090	Rheumatic myocarditis
I0989	Other specified rheumatic heart diseases
I099	Rheumatic heart disease, unspecified
I300	Acute nonspecific idiopathic pericarditis

Code	Description
I308	Other forms of acute pericarditis
I309	Acute pericarditis, unspecified
I310	Chronic adhesive pericarditis
I311	Chronic constrictive pericarditis
I312	Hemopericardium, not elsewhere classified
I314	Cardiac tamponade
I32	Pericarditis in diseases classified elsewhere
I330	Acute and subacute infective endocarditis
I339	Acute and subacute endocarditis, unspecified
I39	Endocarditis and heart valve disorders in diseases classified elsewhere
I400	Infective myocarditis
I401	Isolated myocarditis
I408	Other acute myocarditis
I409	Acute myocarditis, unspecified
I41	Myocarditis in diseases classified elsewhere
I514	Myocarditis, unspecified
Acute ICD-9-CM codes within Diagnosis CCS 105: Conduction disorders	
4260	Atrioventricular
42610	Atrioventricular block NOS
42611	Atrioventricular block-1st degree
42612	Atrioventricular block-Mobitz II
42613	Atrioventricular block-2nd degree NEC
4262	Left bundle branch hemiblock
4263	Left bundle branch block NEC
4264	Right bundle branch block
42650	Bundle branch block NOS
42651	Right bundle branch block/left posterior fascicular block
42652	Right bundle branch block/left ant fascicular block
42653	Bilateral bundle branch block NEC
42654	Trifascicular block
4266	Other heart block
4267	Anomalous atrioventricular excitation
42681	Lown-Ganong-Levine syndrome
42682	Long QT syndrome
4269	Conduction disorder NOS
Acute ICD-10-CM codes within Diagnosis CCS 105: Conduction disorders	
I442	Atrioventricular block, complete

Code	Description
I4430	Unspecified atrioventricular block
I440	Atrioventricular block, first degree
I441	Atrioventricular block, second degree
I4469	Other fascicular block
I444	Left anterior fascicular block
I445	Left posterior fascicular block
I4460	Unspecified fascicular block
I447	Left bundle-branch block, unspecified
I4510	Unspecified right bundle-branch block
I4430	Unspecified atrioventricular block
I4439	Other atrioventricular block
I454	Nonspecific intraventricular block
I452	Bifascicular block
I453	Trifascicular block
I455	Other specified heart block
I456	Pre-excitation syndrome
I4581	Long QT syndrome
I459	Conduction disorder, unspecified
Acute ICD-9-CM codes within Diagnosis CCS 106: Dysrhythmia	
4272	Paroxysmal tachycardia NOS
7850	Tachycardia NOS
42789	Cardiac dysrhythmias NEC
4279	Cardiac dysrhythmia NOS
42769	Premature beats NEC
Acute ICD-10-CM codes within Diagnosis CCS 106: Dysrhythmia	
I479	Paroxysmal tachycardia, unspecified
I4949	Other premature depolarization
I498	Other specified cardiac arrhythmias
I499	Cardiac arrhythmia, unspecified
R000	Tachycardia, unspecified
R001	Bradycardia, unspecified
Acute ICD-9-CM codes within Diagnosis CCS 108: Congestive heart failure; non-hypertensive	
39891	Rheumatic heart failure
4280	Congestive heart failure
4281	Left heart failure
42820	Unspecified systolic heart failure
42821	Acute systolic heart failure

Code	Description
42823	Acute on chronic systolic heart failure
42830	Unspecified diastolic heart failure
42831	Acute diastolic heart failure
42833	Acute on chronic diastolic heart failure
42840	Unspecified combined systolic & diastolic heart failure
42841	Acute combined systolic & diastolic heart failure
42843	Acute on chronic combined systolic & diastolic heart failure
4289	Heart failure NOS
Acute ICD-10-CM codes within Diagnosis CCS 108: Congestive heart failure; non-hypertensive	
I0981	Rheumatic heart failure
I509	Heart failure, unspecified
I501	Left ventricular failure
I5020	Unspecified systolic (congestive) heart failure
I5021	Acute systolic (congestive) heart failure
I5023	Acute on chronic systolic (congestive) heart failure
I5030	Unspecified diastolic (congestive) heart failure
I5031	Acute diastolic (congestive) heart failure
I5033	Acute on chronic diastolic (congestive) heart failure
I5040	Unspecified combined systolic and diastolic (congestive) heart failure
I5041	Acute combined systolic (congestive) and diastolic (congestive) heart failure
I5043	Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure
I509	Heart failure, unspecified
Acute ICD-9-CM codes within Diagnosis CCS 149: Biliary tract disease	
5740	Calculus of gallbladder with acute cholecystitis
57400	Calculus of gallbladder with acute cholecystitis without mention of obstruction
57401	Calculus of gallbladder with acute cholecystitis with obstruction
5743	Calculus of bile duct with acute cholecystitis
57430	Calculus of bile duct with acute cholecystitis without mention of obstruction
57431	Calculus of bile duct with acute cholecystitis with obstruction
5746	Calculus of gallbladder and bile duct with acute cholecystitis
57460	Calculus of gallbladder and bile duct with acute cholecystitis without mention of obstruction
57461	Calculus of gallbladder and bile duct with acute cholecystitis with obstruction
5748	Calculus of gallbladder and bile duct with acute and chronic cholecystitis
57480	Calculus of gallbladder and bile duct with acute and chronic cholecystitis without mention of obstruction

Code	Description
57481	Calculus of gallbladder and bile duct with acute and chronic cholecystitis with obstruction
5750	Acute cholecystitis
57512	Acute and chronic cholecystitis
5761	Cholangitis
Acute ICD-10-CM codes within Diagnosis CCS 149: Biliary tract disease	
K8000	Calculus of gallbladder with acute cholecystitis w/o obstruction
K8001	Calculus of gallbladder with acute cholecystitis with obstruction
K8042	Calculus of bile duct with acute cholecystitis w/o obstruction
K8043	Calculus of bile duct with acute cholecystitis with obstruction
K8062	Calculus of GB and bile duct with acute cholecystitis w/o obstruction
K8063	Calculus of GB and bile duct with acute cholecystitis with obstruction
K8066	Calculus of GB and bile duct with acute and chronic cholecystitis w/o obstruction
K8067	Calculus of GB and bile duct with acute and chronic cholecystitis with obstruction
K810	Acute cholecystitis
K812	Acute cholecystitis with chronic cholecystitis
K830	Cholangitis
Acute ICD-9-CM codes with Diagnosis CCS 152: Pancreatic disorders	
5770	Acute Pancreatitis
Acute ICD-10-CM codes with Diagnosis CCS 152: Pancreatic disorders	
K859	Acute pancreatitis, unspecified

Appendix C: Measure Score Calculation and Reporting

C1. Risk-Standardized Measure Score Calculation Algorithm

We will fit a hierarchical generalized linear model (HGLM), which will account for the clustering of observations within ASCs. We assume the outcome is a known exponential family distribution and is related linearly to the covariates via a known linked function, *h*. For our model, we assume a binomial distribution and a logit link function. Further, we account for the clustering within an ASC by estimating a facility-specific effect, α_i, which is assumed to follow a normal distribution with mean μ and variance τ^2, the between-facility variance component. The HGLM is defined by the following equations:

$$h(Y_{ij}) = \alpha_i + \beta \mathbf{Z}_{ij} \quad (1)$$

$$\alpha_i = \mu + \omega_i;\ \omega_i \sim N(0, \tau^2) \quad (2)$$

$$i = 1 \ldots I; j = 1 \ldots$$

Where Y_{ij} denotes the outcome (equal to 1 if patient has an eligible hospital visit within 7 days of a surgery procedure, 0 otherwise) for the *j-th* patient who had a surgery procedure at the *i-th* ASC; $\mathbf{Z}_{ij} = (Z_{1ij}, Z_{2ij}, \ldots, Z_{pij})$ is a set of *p* patient-specific covariates derived from the data; and *I* denotes the total number of ASCSs and n_i the number of surgeries performed at ASC *i*. The facility-specific intercept of the *i-th* ASC, α_i, defined above, is comprised of μ, the adjusted average intercept over all ASCs in the sample and ω_i the facility-specific intercept deviation from μ. A point estimate of ω_i, greater or less than 0, determines if ASC performance is worse or better compared to the adjusted average outcome.

The HGLM is estimated using the SAS software system (GLIMMIX procedure).

C2. Provider Performance Reporting

Using the HGLM defined by Equations (1) - (2), we estimate the parameters $\hat{\mu}$, $\{\hat{\alpha}_1, \hat{\alpha}_2, \ldots, \hat{\alpha}_I\}$, $\hat{\beta}$, and $\hat{\tau}^2$. We calculate the measure score, s_i, for each ASC by computing the ratio of the number of predicted hospital visits to the number of expected hospital visits. Specifically, we calculate:

Predicted $\quad \hat{y}_{ij}(Z) = h^{-1}(\hat{\alpha}_i + \hat{\beta}\mathbf{Z}_{ij})$

Expected $\quad \hat{e}_{ij}(Z) = h^{-1}(\hat{\mu} + \hat{\beta}\mathbf{Z}_{ij})$

Measure score $$\hat{s}_i(Z) = \frac{\sum_{j=1}^{n_i} \hat{y}_{ij}(Z)}{\sum_{j=1}^{n_i} \hat{e}_{ij}(Z)}$$

If the "predicted" number of hospital visits is higher (lower) than the "expected" number of hospital visits, then $\hat{s}_i$ that ASC's will be higher (lower) than 1.0.

The risk-standardized hospital visit rate (RSHVR) is calculated by multiplying the measure score by the national observed hospital visit rate.

C3. Outlier Evaluation

Because the measure score is a complex function of parameter estimates, we use re-sampling and simulation techniques to derive an interval estimate to determine if an ASC is performing better than, worse than, or no different from expected. An ASC is considered better than expected if its entire standardized rate ratio interval estimate falls below 1, and considered worse if the entire confidence interval falls above 1. It is considered no different if the confidence interval overlaps 1.

More specifically, we use a bootstrapping procedure to compute confidence intervals. Because the theoretical-based standard errors are not easily derived, and to avoid making unnecessary assumptions, we use the bootstrap to empirically construct the sampling distribution for each facility-level risk-standardized rate. The bootstrapping algorithm is described below.

C4. Bootstrapping Algorithm

Let *I* denote the total number of ASCs in the sample. We repeat steps 1 – 4 below for b = 1,2,…B times:

1. Sample *I* ASCs with replacement.
2. Fit the hierarchical logistic regression model using all patients within each sampled ASC. We use as starting values the parameter estimates obtained by fitting the model to all ASCs. If some ASCs are selected more than once in a bootstrapped sample, we treat them as distinct so that we have *I* random effects to estimate the variance components. At the conclusion of Step 2, we have:
   a. $\hat{\beta}^{(b)}$ (the estimated regression coefficients of the risk factors).
   b. The parameters governing the random effects, ASC adjusted outcomes, distribution, $\hat{\mu}^{(b)}$ and $\hat{\tau}^{2(b)}$.
   c. The set of facility-specific intercepts and corresponding variances:

$$\{\hat{\alpha}_i^{(b)},\ \hat{\text{var}}\left(\alpha_i^{(b)}\right);\ i = 1,2,\ldots,I\}.$$

3. We generate an ASC random effect by sampling from the distribution of the facility-specific distribution obtained in Step 2c. We approximate the distribution for each random effect by a normal distribution. Thus, we draw $\alpha_i^{(b^*)} \sim N\left(\hat{\alpha}_i^{(b)}, \hat{\text{var}}\left(\hat{\alpha}_i^{(b)}\right)\right)$ for the unique set of ASCs sampled in Step 1.

4. Within each unique ASC *i* sampled in Step 1, and for each case *j* in that ASC, we calculate $\hat{y}_{ij}^{(b)}$, $\hat{e}_{ij}^{(b)}$, and $\hat{s}_i\left(Z\right)^{(b)}$ where $\hat{\beta}^{(b)}$ and $\hat{\mu}^{(b)}$ are obtained from Step 2 and $\hat{\alpha}_i^{(b^*)}$ is obtained from Step 3.

Ninety-five percent interval estimates (or alternative interval estimates) for the ASC-standardized outcome can be computed by identifying the 2.5th and 97.5th percentiles of randomly half of the B estimates (or the percentiles corresponding to the alternative desired intervals).

Appendix D: Risk-Adjustment Model Development

Table D1. Candidate variables considered for the risk-adjustment model

Patient demographic, comorbidity, and procedural complexity candidate variables for risk adjustment	
Variable category	**Definition**
Age	-
Sex	-
Number of qualifying procedures	Defined as 1, 2, or ≥3
Work Relative Value Units (work RVUs)	Work RVUs are assigned to each CPT® procedure code and approximate procedure complexity by incorporating elements of physician time and effort
History of infection	Condition Category (CC) 1, 3, 4, 5, 6, 7
Septic shock	CC 2
Cancer	CC 8, 9, 10, 11, 12, 13, 14
Diabetes and diabetes mellitus complications	CC 17, 18, 19, 122, 123
Protein-calorie malnutrition	CC 21
Disorders off fluid/electrolyte/acid-base	CC 23, 24
Other endocrine/metabolic/nutritional disorders	CC 26
Liver disease	CC 27, 28, 29, 30, 31, 32
Intestinal obstruction/perforation	CC 33
Inflammatory bowel disease	CC 35
Pancreatic disease; and peptic ulcer, hemorrhage, other specified gastrointestinal disorders	CC 34, 36
Other gastrointestinal disorders	CC 38
Bone/joint/muscle Infections/necrosis	CC 39
Rheumatoid and osteoarthritis	CC 40, 41, 42
Osteoporosis and other bone/cartilage disorders	CC 43
Hematological disorders including coagulation defects and iron deficiency	CC 46, 48, 49
Disorders of immunity	CC 47
Delirium and encephalopathy	CC 50
Dementia or senility	CC 51, 52, 53
Drug and alcohol abuse/dependence	CC 54, 55, 56 (remove ICD-9-CM diagnosis code 3051)
Other alcohol/drug abuse	CC 55 (remove ICD-9-CM codes 30400, 30401, 30402, 30403, 30470, 30471, 30472, 30473), CC 56 (remove ICD-9-CM codes 30550, 30551, 30552, 30553)
Psychiatric disorders	CC 57, 58, 59, 60, 61, 62, 63

Patient demographic, comorbidity, and procedural complexity candidate variables for risk adjustment	
Variable category	**Definition**
Hemiplegia, paraplegia, paralysis, functional disability	CC 70, 71, 73, 74, 103, 104, 189, 190
Multiple sclerosis	CC 77
Parkinson's and Huntington's diseases	CC 78
Seizure disorders and convulsions	CC 79
Coma, brain compression/anoxic damage	CC 80
Other significant central nervous system (CNS) disease	CC 77, 78, 79, 80
Cardiorespiratory arrest, failure and respiratory dependence	CC 82, 83, 84
Congestive heart failure	CC 85
Ischemic heart disease	CC 86, 87, 88, 89
Hypertension and hypertensive disease	CC 94, 95
Arrhythmias	CC 96, 97
Other and unspecified heart disease	CC 98
Polyneuropathy	CC 75, 81
Valvular and rheumatic heart disease	CC 91
Congenital cardiac/circulatory defect	CC 92, 93
Stroke	CC 99, 100
Precerebral arterial occlusion/transient ischemic attack (TIA)	CC 101
Cerebral atherosclerosis, aneurysm, and other cerebrovascular disease (CVD)	CC 102, 105
Vascular disease	CC 106, 107, 108, 109
Chronic lung disease	CC 111, 112, 113
Pneumonia	CC 114, 115, 116
Pleural effusion/pneumothorax	CC 117
Other Respiratory disorders	CC 118
Retinal detachments	CC 121
Retinal disorders, except detachment and vascular retinopathies	CC 125
Glaucoma	CC 126
Other eye disorders	CC 128
Significant ear, nose, and throat disorders	CC 129
Hearing loss	CC 130
Other ear, nose, throat, and mouth disorders	CC 131
Chronic renal disease	CC 132, 134, 135, 136, 137, 138, 139, 140
Nephritis	CC 141
Urinary obstruction and retention	CC 142
UTI and other urinary track disorders	CC 144, 145

Patient demographic, comorbidity, and procedural complexity candidate variables for risk adjustment	
Variable category	**Definition**
Pelvic inflammatory disease and other specified female genital disorders	CC 147
Male genital disorders	CC 149
Chronic ulcers	CC 157, 158, 159, 160, 161
Cellulitis, local skin infection	CC 164
Other dermatological disorders	CC 165
Head injury	CC 166, 167, 168
Major traumatic fracture or Internal Injury	CC 170, 171, 172
Poisonings and allergic reactions	CC 175
Complications of specified implanted device or graft	CC 176
Other complications of medical care	CC 177
Major symptoms, abnormalities	CC 178
Minor symptoms, signs, findings	CC 179
Organ transplant	CC 186, 187
Morbid obesity	ICD-9-CM diagnosis codes: • 27801 (morbid obesity) • V8541 (Body Mass Index [BMI] 40.0-44.9, adult) • V8542 (BMI 45.0-49.9, adult) • V8543 (BMI 50.0-59.9, adult) • V8544 (BMI 60.0-69.9, adult) • V8545 (BMI 70 and over, adult) ICD-10-CM diagnosis codes: • E6601 (morbid [severe] obesity due to excess calories) • Z6841 (BMI 40.0-44.9, adult) • Z6842 (BMI 45.0-49.9, adult) • Z6843 (BMI 50-59.9, adult) • Z6844 (BMI 60.0-69.9, adult) • Z6845 (BMI 70 or greater, adult)
Opioid abuse	ICD-9-CM diagnosis codes: • 30400: Opioid dependence-unspec opioid type dependence, unspecified) • 30401: Opioid dependence-contin (opioid type dependence, continuous) • 30402: Opioid dependence-episod (opioid type dependence, episodic) • 30403: Opioid dependence-remiss (opioid type dependence, in remission) • 30470: Opioid/other dep-unspec (combinations of opioid type drug with any other drug dependence, unspecified)

Patient demographic, comorbidity, and procedural complexity candidate variables for risk adjustment	
Variable category	**Definition**
Opioid abuse	ICD-9-CM diagnosis codes: • 30471: Opioid/other dep-unspec (combinations of opioid type drug with any other drug dependence, unspecified) • 30472: Opioid/other dep-episod (combinations of opioid type drug with any other drug dependence, episodic) • 30403: Opioid/other dep-remiss (combinations of opioid type drug with any other drug dependence, in remission) • 30550: Opioid abuse-unspec (opioid abuse, unspecified) • 30551: Opioid abuse-continuous (opioid abuse, continuous) • 30552: Opioid abuse-episodic (opioid abuse, episodic) • 30553: Opioid abuse-in remiss (opioid abuse, in remission)
Opioid abuse	ICD-10-CM diagnosis codes: • F1119: Opioid abuse with unspecified opioid-induced disorder • F1120: Opioid dependence, uncomplicated • F1121: Opioid dependence, in remission • F11220: Opioid dependence with intoxication, uncomplicated • F11221: Opioid dependence with intoxication delirium • F11222: Opioid dependence with intoxication with perceptual disturbance • F11229: Opioid dependence with intoxication, unspecified • F1123: Opioid dependence with withdrawal • F1124: Opioid dependence with opioid-induced mood disorder • F11250: Opioid dependence with opioid-induced psychotic disorder with delusions • F11251: Opioid dependence with opioid-induced psychotic disorder with hallucinations • F11259: Opioid dependence with opioid-induced psychotic disorder, unspecified • F11281: Opioid dependence with opioid-induced sexual dysfunction • F11282: Opioid dependence with opioid-induced sleep disorder • F11288: Opioid dependence with other opioid-induced disorder

Patient demographic, comorbidity, and procedural complexity candidate variables for risk adjustment	
Variable category	**Definition**
Opioid abuse	ICD-10-CM diagnosis codes: • F1129: Opioid dependence with unspecified opioid-induced disorder • F1110: Opioid abuse, uncomplicated • F11120: Opioid abuse with intoxication, uncomplicated • F11121: Opioid abuse with intoxication delirium • F11122: Opioid abuse with intoxication with perceptual disturbance • F11129: Opioid abuse with intoxication, unspecified • F1114: Opioid abuse with opioid-induced mood disorder • F11150: Opioid abuse with opioid-induced psychotic disorder with delusions • F11151: Opioid abuse with opioid-induced psychotic disorder with hallucinations • F11159: Opioid abuse with opioid-induced psychotic disorder, unspecified • F11181: Opioid abuse with opioid-induced sexual dysfunction • F11182: Opioid abuse with opioid-induced sleep disorder F11188: Opioid abuse with other opioid-induced disorder
Tobacco use disorder	ICD-9-CM diagnosis code 3051 (tobacco use disorder) ICD-10-CM diagnosis code F17200 (nicotine dependence, unspecified, uncomplicated)
Chronic anticoagulant use	ICD-9-CM diagnosis code V5861 (long-term [current] use of anticoagulants) ICD-10-CM diagnosis code Z7901 (long-term [current] use of anticoagulants)

Table D2. Condition Categories (CCs) that are not risk-adjusted for if they occur only at the time of the procedure

Condition Category (CC)	CC description
CC 2	Septicemia, sepsis, systemic inflammatory response syndrome/shock
CC 7	Other infectious diseases
CC 17	Diabetes with acute complications
CC 24	Disorders of fluid/electrolyte/acid-base
CC 30	Acute liver failure/disease
CC 33	Intestinal obstruction/perforation
CC 36	Peptic ulcer, hemorrhage, other specified gastrointestinal disorders
CC 50	Delirium and encephalopathy
CC 80	Coma, brain compression/anoxic damage
CC 82	Respirator dependence/tracheostomy status
CC 83	Respiratory arrest
CC 84	Cardio-respiratory failure and shock
CC 85	Congestive heart failure
CC 86	Acute myocardial infarction
CC 87	Unstable angina and other acute ischemic heart disease
CC 96	Specified heart arrhythmias
CC 97	Other heart rhythm and conduction disorders
CC 98	Other and unspecified heart disease
CC 99	Cerebral hemorrhage
CC 100	Ischemic or unspecified stroke
CC 101	Precerebral arterial occlusion and transient cerebral ischemia
CC 103	Hemiplegia/hemiparesis
CC 104	Monoplegia, other paralytic syndromes
CC 107	Vascular disease with complications
CC 114	Aspiration and specified bacterial pneumonias
CC 115	Pneumococcal pneumonia, emphysema, lung abscess
CC 117	Pleural effusion/pneumothorax
CC 135	Acute renal failure
CC 140	Unspecified renal failure
CC 141	Nephritis
CC 142	Urinary obstruction and retention
CC 144	Urinary tract infection
CC 164	Cellulitis, local skin infection
CC 168	Concussion or unspecified head injury
CC 175	Poisonings and allergic and inflammatory reactions
CC 176	Complications of specified implanted device or graft
CC 177	Other complications of medical care