

Cost Measure Methodology for the Knee Arthroplasty Measure

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1.0 Introduction

The Knee Arthroplasty cost measure represents the amount Medicare pays for a beneficiary's clinically related medical care during a defined episode of care for knee arthroplasty. This document details the methodology for this measure. It should be reviewed together with the corresponding Measure Codes List file, which contains the medical codes used in constructing the measure.¹

This document is divided into three main sections that provide increasingly detailed information on the cost measure.

- **Section 1** provides an overview of the project and the Knee Arthroplasty cost measure.
- **Section 2** summarizes the process for each component of measure development and briefly describes the methodology.
- **Section 3** provides the detailed measure construction methodology and logic steps; they are the technical details for the concepts described in Section 2.

Within Section 1, Section 1.1 provides background on the MACRA Episode Groups and Cost Measures project. Section 1.2 provides an overview of episode-based cost measures. Section 1.3 describes the overall process used to develop the Knee Arthroplasty cost measure, and Section 1.4 summarizes the justification for and basic information about the Knee Arthroplasty cost measure.

1.1 Project Background

The Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) introduced a new approach to clinician payment called the Quality Payment Program. This program rewards the delivery of high-quality patient care through Advanced Alternative Payment Models (Advanced APMs) and the Merit-based Incentive Payment System (MIPS). Clinician performance is assessed under MIPS in four performance categories—quality, clinical practice improvement activities (“improvement activities”), meaningful use of certified electronic health record technology (“advancing care information”), and resource use (“cost”). MACRA requires that cost measures implemented in MIPS include consideration of episode groups. CMS has contracted with Acumen, LLC (“Acumen”) to develop episode groups and associated episode-based cost measures for potential use in the MIPS cost performance category of the Quality Payment Program through the MACRA Episode Groups and Cost Measures contract (HHSM-500-2013-130021/HHSM-500-T0002). Acumen has implemented a measure development process that relies on input from a large number of stakeholders, including multiple groups of clinicians affiliated with a broad range of professional societies, to develop clinically appropriate and transparent measures that provide actionable information to clinicians.

1.2 Overview of Episode-Based Cost Measures

Episode-based cost measures represent the cost to Medicare for the items and services provided to a patient during an episode of care (“episode”). An episode-based cost measure is designed to inform clinicians on the cost of their beneficiary's care for which they are responsible during the timeframe specified by the episode. In all supplemental documentation, the term “cost” denotes the payment-standardized amount Medicare pays on the traditional, fee-

¹ “Knee Arthroplasty Measure Codes List,” *Quality Payment Program*, <https://qpp.cms.gov>.

for-service claims.² Payment standardization is intended to remove any Medicare payment differences due to adjustments for geographic differences in wage levels or policy-driven payment adjustments, such as those for teaching hospitals.³

Episode-based cost measures are based on episode groups. An *episode group* is a unit of comparison that represents a clinically coherent set of medical services rendered to treat a given medical condition. Episode groups aggregate these items and services involved in care for a defined patient cohort to assess the total cost of the care. Services assigned to the episode group might include diagnostic services, treatment services, and ancillary items and services directly related to treatment (such as anesthesia for a surgical procedure), as well as services following the initial treatment period that may be rendered to patients as routine follow-up care or to treat consequences of care. An *episode* is a specific instance of an episode group for a given patient and clinician. For example, in a given year, a clinician might be attributed 20 episodes (instances of the episode group) from the episode group for heart failure.

There are currently three types of episode groups that can serve as the basis for cost measures: procedural, acute inpatient medical condition, and chronic condition. *Procedural* episode groups focus on procedures of a defined purpose or type, such as hip arthroplasty or cholecystectomy. *Acute inpatient medical condition* episode groups represent treatment for a defined acute illness or treatment for flares or exacerbations of a condition requiring hospitalization, such as acute myocardial infarction (AMI), renal failure, or gastrointestinal (GI) bleed. *Chronic condition* episode groups represent ongoing management of a long-term health condition, such as diabetes.⁴

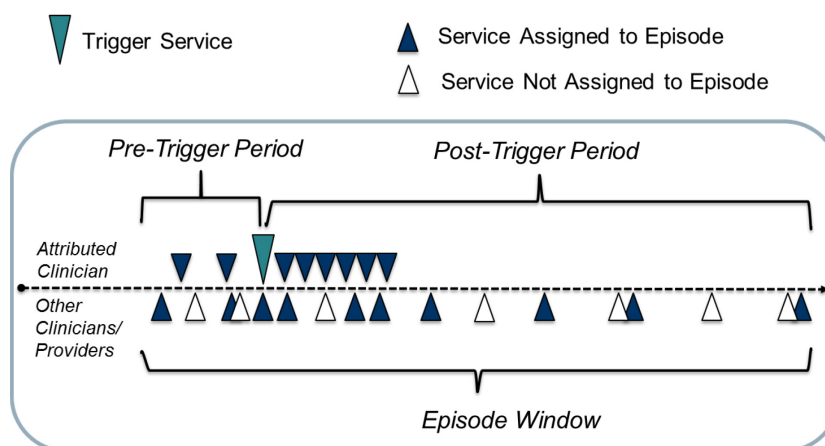
Episode-based cost measures are intended to measure clinician resource use based on only those costs that occur as part of an attributed clinician's management of a defined condition or procedure. In other words, only services occurring during the episode window that are clinically related to the treatment provided by the attributed clinician are assigned to the episode and included in episode-based cost measure calculations (see Figure 1 below). For example, an episode group for elective outpatient percutaneous coronary intervention (PCI) would include services furnished for and complications related to this procedure, such as electrographic cardiac monitoring, a subsequent PCI, or readmission for gastrointestinal bleed. As a result, the episode group for elective outpatient PCI would allow comparison of clinicians providing this procedure across an episode of care.

² Specifically, cost is defined by payment-standardized allowed amounts on Medicare claims data, which include both Medicare trust fund payments and beneficiary deductible and coinsurance. Only claims data from Medicare Parts A and B are used to construct the episode-based cost measures.

³ For more information on payment standardization, please refer to the "CMS Price (Payment) Standardization - Basics" and "CMS Price (Payment) Standardization - Detailed Methods" documents posted on this QualityNet webpage:
<http://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic/Page/QnetTier4&cid=1228772057350>

⁴ No chronic condition episode groups are included in the first set of eight episode-based cost measures developed for this project. Chronic condition episode groups will be developed at a later stage of measure development.

Figure 1. Assignment of Services to an Episode



Furthermore, to ensure a more accurate comparison of cost across clinicians, risk adjustment is applied to account for characteristics of patients that can influence spending and are outside of the clinician's control. For instance, for the elective outpatient PCI episode-based cost measure, the risk adjustment model may account for a patient's history of heart failure.

1.3 Process for Developing the Knee Arthroplasty Cost Measure

Stakeholder input is critical to the development of robust, meaningful, and actionable episode-based cost measures. Throughout the measure development process, Acumen sought input from clinicians and other stakeholders to inform the development of the Knee Arthroplasty cost measure. Acumen incorporated input from the following stakeholder input activities:

- (i) Clinical Subcommittees, further explained in Section 1.3.1;
- (ii) Technical Expert Panel (TEP), further explained in Section 1.3.2;
- (iii) Person and Family Committee (PFC), further explained in Section 1.3.3; and
- (iv) Stakeholder Feedback and Field Testing, further explained in Section 1.3.4.

The Clinical Subcommittees make recommendations about clinical specifications for episode-based cost measures while the TEP serves a high-level advisory role and provides guidance on the overall direction of measure development. The PFC provides feedback from persons and families to inform key components of cost measure development with patient and caregiver perspectives. The field testing and public feedback periods offer all stakeholders an opportunity to provide input on the cost measurement approach. The remaining sub-sections of this section describe each stakeholder input activity and its role in the development of episode-based cost measures for this project.

1.3.1 Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee

Acumen convened seven Clinical Subcommittees in May 2017 – January 2018 to select episode groups to develop into cost measures and to provide input on the measures' specifications. The Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee focused on developing the Knee Arthroplasty episode-based cost measure.

The work of the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee builds off of the previous work of the August – September 2016 Clinical Committee that was also convened as a part of this project. This Committee included more than 70 clinicians from over 50 professional societies who provided expert input on identifying a draft list of episode

groups for cost measure development and determining the billing codes that trigger each episode group. The clinical review and recommendations obtained from the Clinical Committee were used to inform CMS's posting in December 2016 of a Draft List of MACRA Episode Groups and Trigger Codes and an accompanying document on episode-based cost measure development for the Quality Payment Program (together, the "December 2016 posting").^{5,6} This draft list of episode groups and episode trigger codes served as a starting point for measure development.

Acumen uses a "wave" approach wherein sets of Clinical Subcommittees, each focused on a particular clinical area, convene to provide structured clinical input on the components of episode-based cost measures, including refinements to the episode groups and episode trigger codes included in the December 2016 posting. The first wave included seven Clinical Subcommittees with a total of 148 members affiliated with 98 professional societies. The seven Clinical Subcommittees in Wave 1 that contributed to the development of eight episode-based cost measures between May 2017 and January 2018 were:

- (i) Cardiovascular Disease Management,
- (ii) Gastrointestinal Disease Management - Medical and Surgical,
- (iii) Musculoskeletal Disease Management - Non-Spine,
- (iv) Neuropsychiatric Disease Management,
- (v) Ophthalmologic Disease Management,
- (vi) Peripheral Vascular Disease Management, and
- (vii) Pulmonary Disease Management.

Members of these seven Clinical Subcommittees were nominated through a Call for Clinical Subcommittees Nominations, which was posted on March 17, 2017, and closed on April 24, 2017. The Clinical Subcommittees in each wave are expected to convene on an ongoing basis to select episode groups for development and make recommendations about the clinical specifications for the episode groups. Future Clinical Subcommittees under this project, including Subcommittees focused on chronic condition episode group development, will be convened through separate nomination periods.

For the Knee Arthroplasty cost measure, 28 Clinical Subcommittee members affiliated with 27 specialty societies participated throughout the cost measure development process. This Subcommittee selected the episode group from the December 2016 posting (originally referred to as the "Total Knee Replacement" episode group in this posting) and provided input on all components of the Knee Arthroplasty cost measure described in this document. The names of the Subcommittee members and their organizational affiliations are presented in Table A-1 of Appendix A. Table A-1 also denotes the two Subcommittee co-chairs, whose role was to facilitate discussion and assist in reaching consensus on cost measure development recommendations.

The seven Wave 1 Clinical Subcommittees fully developed a total of eight episode-based cost measures that were reported to clinicians during field testing in October – November 2017.

⁵ CMS, "Draft List of MACRA Episode Groups and Trigger Codes", *MACRA Feedback Page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/draft-list-of-care-episode-and-patient-condition-groups-and-codes.zip>

⁶ CMS, "Episode-Based Cost Measure Development for the Quality Payment Program", *MACRA Feedback Page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/Episode-Based-Cost-Measure-Development-for-the-Quality-Payment-Program.pdf>

Subcommittee members provided input via an in-person meeting in June 2017, five webinars, various polls, and web portal discussion threads for the selection of the following aspects of the cost measure's specifications: (i) episode group(s) to develop into cost measure(s), (ii) episode triggers and sub-groups, (iii) episode window, (iv) service assignment rules, (v) risk adjustors, and (vi) exclusions. After field testing, the Clinical Subcommittee also revisited and refined the draft measure specifications for the Knee Arthroplasty cost measure in two additional webinars based on the stakeholder feedback received. Clinical Subcommittee members made recommendations through polls in which voting consensus of greater than 60 percent was sought.

1.3.2 Technical Expert Panel

Acumen convened five TEP meetings to gather high-level guidance on measure development process from expert stakeholders. The advisory panel, which consists of 21 expert stakeholders representing specialty societies, academia, health care administration, and patient and family member organizations, was selected following a public call for nominations.⁷ Each TEP meeting centered on particular topics to gather comprehensive feedback that could be operationalized throughout the episode group and cost measure development process. Table 1 below summarizes the five TEP meetings to date. Future TEP meetings are planned to gather essential expert input on topics such as chronic condition episode group development.

Table 1. MACRA Episode-Based Cost Measures TEP Meetings (August 2016 – May 2018)

Meeting Information	Meeting Date	Meeting Topic(s)
TEP 1 (In-Person Meeting)	August 2016	<ul style="list-style-type: none"> • Concepts of episode-based cost measure development • Alignment of cost measures and quality measures • Prioritization of cost measures for development
TEP 2 (In-Person Meeting)	December 2016	<ul style="list-style-type: none"> • Methodological approaches to cost measure development and service assignment for procedural and acute inpatient medical condition episode groups
TEP 3 (Webinar)	March 2017	<ul style="list-style-type: none"> • Clinical area prioritization into waves for future episode-based cost measure development (led by Acumen) • Alignment of cost measures and quality measures (led by Yale-New Haven Health Services Corporation, Center for Outcomes Research and Evaluation (CORE))
TEP 4 (In-Person Meeting)	August 2017	<ul style="list-style-type: none"> • Risk adjustment • Measure maintenance and re-evaluation for other cost measures (i.e., Medicare Spending Per Beneficiary (MSPB) measure for clinicians and the Total Per Capita Cost measure)

⁷ CMS, "Quality Measures Call for Technical Expert Panel Members," *CMS Measures Management System*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/Technical-Expert-Panels.html>

Meeting Information	Meeting Date	Meeting Topic(s)
TEP 5 (In-Person Meeting)	May 2018	<ul style="list-style-type: none"> • Measure score reporting for episode-based cost measures • Incorporating person and family perspectives into the measure development process • Measure maintenance and re-evaluation for other cost measures (i.e., Medicare Spending Per Beneficiary (MSPB) measure for clinicians and the Total Per Capita Cost measure)

1.3.3 Person and Family Committee

Acumen and its subcontractor, Westat, have been convening a PFC since spring 2017 to gather actionable input from patients and caregivers for the cost measure development process. The PFC comprises Medicare beneficiaries and caregiver/family members of a Medicare beneficiary who have experience with health care and/or patient advocacy, health care delivery, concepts of value, and outcomes that are important to patients across delivery/disease/episodes of care.

To date, eight PFC members have been recruited and have provided initial input through one-on-one meetings regarding how they think about health care quality, value, and payment. For future waves of cost measure development, PFC members will be asked for input on episode group selection, episode window duration, service assignment, salient quality indicators to align with cost measures, and public reporting of the cost measures. Acumen also hosted a webinar with interested Clinical Subcommittee members in August 2017 to gather feedback on what type of PFC input Clinical Subcommittee members may consider relevant and important for cost measure development. For future engagement, additional PFC members will be recruited to provide more targeted input on relevant topics based on measures selected for future waves of cost measure development.

1.3.4 Stakeholder Feedback and Field Testing

CMS and Acumen sought and incorporated feedback from multiple public feedback periods over the course of the episode group and cost measure development process. Stakeholder feedback has been received through public comments during the formal rulemaking process (such as public comments on the calendar year (CY) 2018 Quality Payment Program proposed rule) as well as through other avenues.

CMS has shared multiple postings on episode groups for public comment. CMS posted the CMS Episode Groups posting in October 2015⁸ and the follow-up Supplemental CMS Episode Groups Posting in April 2016.⁹ Both the October 2015 and April 2016 postings included existing episode-based cost measures that had been developed by CMS in the past pursuant to the requirements of the Affordable Care Act (ACA) of 2010. Some of these episode groups had

⁸ CMS, "Supplementary CMS Episode Groups Posting," *MACRA Feedback Page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/Supplemental-CMS-Episode-Groups-Posting.pdf>

⁹ CMS, "CMS Episode Groups," *MACRA Feedback page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/Episode-groups-summary.pdf>

previously been reported as part of the Supplemental Quality and Resource Use Reports (Supplemental QRURs). Both postings were followed by public comment periods.

In December 2016, CMS posted a list of draft episode groups and episode trigger codes developed as a part of this project for stakeholder feedback as required by Section 101(f) of MACRA. This was accompanied by a document titled “Episode-Based Cost Measure Development for the Quality Payment Program” that outlined the approach to measure development and included specific questions for stakeholders, as listed in Appendix A of the document. During the public comment period from December 23, 2016, to April 24, 2017, Acumen received 69 comments. Stakeholder input gathered from the December 2016 posting public comments was summarized in the December 2016 Posting Public Comment Summary Report. This document is publicly available and includes Acumen’s responses to public comments received from stakeholders.^{10,11}

On April 5, 2017, CMS also hosted a Listening Session to broadly engage with the stakeholder community about the December 2016 posting and the development of episode-based cost measures.¹² The Listening Session webinar, which was attended by approximately 1,170 people, consisted of a 30-minute presentation followed by a one-hour period for attendees to ask questions or provide feedback.

In addition to general public comment summary reports, Acumen has also created episode group-specific public comment summary reports. These reports collected all comments received in response to the October 2015, April 2016, and December 2016 postings relevant to a particular episode group and synthesized the comments to share key takeaways from the feedback provided by commenters. To directly incorporate this feedback in the episode group development process, the episode group-specific public comment summary reports were shared in May 2017 with Wave 1 of the Clinical Subcommittees so they could consider this prior feedback in their recommendations.

In October – November 2017, CMS and Acumen conducted a field testing period wherein any clinicians who were attributed at least 10 episodes from one or more of eight episode-based cost measures received confidential MACRA Episode-Based Cost Measure Field Test Reports (“Field Test Reports”) containing their measure performance information. Up to an estimated 10,628 clinicians and 1,364 clinician groups accessed their reports through the CMS Enterprise Identity Management (EIDM) portal during the field testing period. CMS and Acumen encouraged all stakeholders, including those who did not receive a Field Test Report, to review and provide feedback on the materials which were publicly posted during the field testing period given their relevance to the development of future measures. The materials included: the Draft Cost Measure Methodology for each measure, the Draft Measure Codes List file for each

¹⁰ CMS, “Episode-Based Cost Measure Development for the Quality Payment Program: Public Comment Summary Report,” *MACRA Feedback Page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/Public-Comment-Summary-Report.pdf>

¹¹ CMS, “Episode-Based Cost Measure Development for the Quality Payment Program: Public Comment Summary Report: Verbatim Comments,” *MACRA Feedback Page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/verbatim-comments-report.pdf>

¹² Listening Session: Cost Measure Development (4/5/17), *Quality Payment Program Webinars and Educational Programs*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/Quality-Payment-Program-Events.html>

measure, the Frequently Asked Questions document, a field testing Fact Sheet, and a mock Field Test Report. All materials are available publicly.¹³

During the field testing period, CMS and Acumen sought and collected feedback on the draft measure specifications for the eight measures that were in development in Wave 1 and on the supplemental documentation. CMS and Acumen received 219 submissions of stakeholder feedback during the field testing period through an online survey, including 53 comment letters. Acumen analyzed the episode group-specific field testing feedback and provided summary reports to the Clinical Subcommittees to inform post-field testing measure refinements. A field testing feedback summary report is also publicly available.¹⁴

1.4 Knee Arthroplasty Cost Measure

This section of the report provides a brief overview of information on the Knee Arthroplasty cost measure. Specifically, Section 1.4.1 explains the justification for development of the measure, and Section 1.4.2 provides a high-level summary of the measure information, briefly describing the data sources, care settings, beneficiary cohort, measure outcome, measure numerator, and measure denominator.

Further descriptions of measure information (such as definitions of the episode window, descriptions of attribution of episodes to clinicians, and explanation of the service assignment process) can be found in Section 2, while Section 3 provides the detailed technical specifications used in episode construction and cost measure calculation.

1.4.1 Measure Justification

Clinical Subcommittee members selected episode group(s) to develop into cost measures between May 2017 and January 2018. Recommendations were based on certain criteria vetted by the TEP, such as (i) the potential for impact on Medicare spending, beneficiary coverage, and clinician coverage, (ii) clinical coherence in regards to representing a patient population that has a similar stage and severity of a particular illness or condition, (iii) clinicians' opportunity for improvement on the measure, and (iv) alignment with established quality indicators.

The Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee selected Knee Arthroplasty as the episode-based cost measure for development in Wave 1 because of its potential for high impact in terms of a large affected patient population as well as Medicare spending. An analysis found that among adults in the United States, an estimated 45 percent are at risk for developing knee osteoarthritis at some point in their life, and the rate of Medicare beneficiaries undergoing a Knee Arthroplasty to treat it (or other forms of arthritis) has recently increased. From 2000 to 2006, the rate increased by 58 percent from a rate of 55 per 10,000 to a rate of 87 per 10,000 Medicare beneficiaries.¹⁵ Opportunities for improvement with this measure include potential for a reduction in readmissions and mitigation of Venous Thromboembolism (VTE), which can occur after a Knee Arthroplasty and result in a significantly more expensive and longer hospital stay. Finally, the measure has the potential to apply to the treatment of a fairly homogenous patient population.

¹³ CMS, Episode-Based Cost Measures, MACRA: MIPS & APMs, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/MACRA-MIPS-and-APMs.html>

¹⁴ "Field Testing Feedback Summary Report for Eight MACRA Episode-Based Cost Measures," *Quality Payment Program*, <https://qpp.cms.gov>.

¹⁵ M. G. Cisternas et al., "Racial Disparities in Total Knee Replacement Among Medicare Enrollees -- United States, 2000-2006. (cover story)," *MMWR: Morbidity & Mortality Weekly Report* 58, no. 6 (2009).

1.4.2 Brief Description of Measure

The Knee Arthroplasty cost measure is meant to apply to clinicians who perform elective total and partial knee arthroplasties during the performance period for Medicare beneficiaries. This surgical procedure is meant to replace a patient's own poorly functional knee with an artificial one, thereby reducing pain and increasing mobility. The measure evaluates a clinician's risk-adjusted cost for the episode group by averaging it across all episodes attributed to the clinician. The cost of each episode is the sum of the cost to Medicare for services performed by the attributed clinician and other health care providers over the length of the episode, or "episode window." The cost measure is calculated by determining the risk-adjusted episode cost,¹⁶ averaged across all of a clinician's episodes during the performance period.

The sub-sections below provide a brief overview of the data sources, care settings, beneficiary cohort, outcome, measure numerator, and measure denominator as they relate to calculation of the Knee Arthroplasty cost measure.

1.4.2.1 Data Sources

The Knee Arthroplasty cost measure utilizes the following data sources:

- Medicare Parts A and B claims data from the Common Working File (CWF)
- Enrollment Data Base (EDB)
- Long Term Care Minimum Data Set (LTC MDS)
- Provider Enrollment, Chain and Ownership System (PECOS)

1.4.2.2 Care Settings

The Knee Arthroplasty cost measure can be triggered in the following settings: community hospitals, hospital inpatient, hospital/acute care facility settings, inpatient units within acute care hospitals, ambulatory surgical center (ASC), ambulatory/office-based care, and hospital outpatient department (HOPD).

1.4.2.3 Cohort

The cohort for this episode-based cost measure consists of patients who are Medicare beneficiaries enrolled in Medicare fee-for-service and who undergo a knee arthroplasty procedure triggering a Knee Arthroplasty episode. Patients whose episodes are included in the measure must be continuously enrolled in both Medicare Parts A and B, but not Part C, during the episode window. The cohort does not include beneficiaries receiving Medicare-covered services for which Medicare was not the primary payer. Only patients whose episode end date occurs during the performance period are included in the cohort for the measure; episodes where patient death occurs during the episode window are not included. The cohort for the Knee Arthroplasty cost measure is also further refined by the definition of the episode group (see Section 2.1) and measure-specific exclusions (described further in Section 2.4).

1.4.2.4 Outcome

The primary outcome of the Knee Arthroplasty cost measure is the clinician's average risk-adjusted cost to Medicare across all Knee Arthroplasty episodes attributed to them. The measure includes costs of services that are clinically related to the attributed clinician's role in managing patient care during each episode (during the 30-day period prior to the clinical event

¹⁶ Costs are payment standardized to remove any Medicare payment differences due to adjustments for geographic differences in wage levels or policy-driven payment adjustments, such as those for teaching hospitals.

that opens, or triggers, the episode through 90 days post-trigger). Sections 2.1 through 2.3 provide more details on the trigger event, attribution of episodes, and services assigned to the episode group.

1.4.2.5 Measure Numerator

The numerator of the Knee Arthroplasty cost measure is the sum of the ratio of observed to expected¹⁷ cost to Medicare for all episodes attributed to a clinician. This is then multiplied by the national average observed episode cost to generate a dollar figure.

1.4.2.6 Measure Denominator

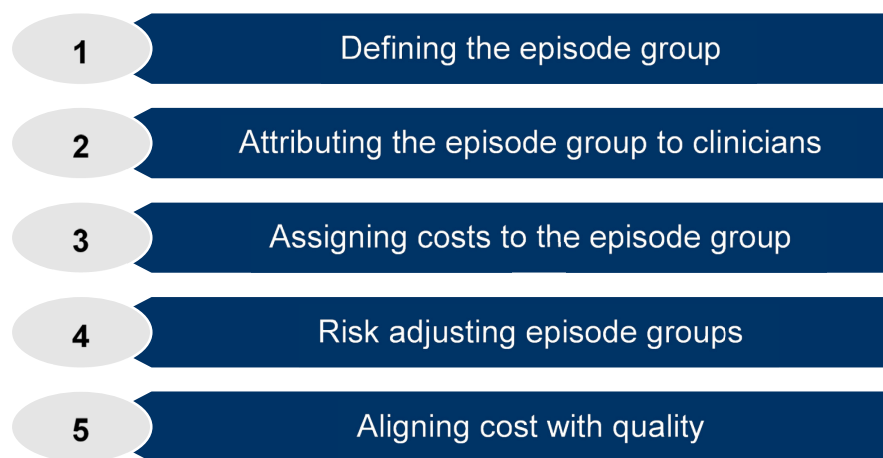
The cost measure denominator is the total number of episodes from the Knee Arthroplasty episode group attributed to a clinician.

¹⁷ Expected costs refer to costs predicted by the risk adjustment model. For more information on expected costs and risk adjustment, please refer to Sections 2.4 and 3.2.6.

2.0 Components of the Episode-Based Cost Measure

Episode-based cost measures have five essential components, as shown in Figure 2 below: (1) defining the episode group; (2) attributing the episode group to the responsible clinician(s); (3) assigning costs to the episode group; (4) risk adjusting episode group costs; and (5) aligning episode group costs with quality. The following sections describe each component in turn, summarize the process used for developing that component, and provide a high-level description of the methodology used for the component in the Knee Arthroplasty cost measure. For those interested in detailed technical information on the specifications used in the measure methodology, please see Section 3.

Figure 2. Components of Episode-Based Cost Measures



2.1 Definition of the Episode Group

This section describes the first component of episode-based cost measures: the definition of the episode group.

2.1.1 Description of this Component

Episodes are defined by the codes that trigger (or open) the episode group, as these codes determine the patient cohort that is included in the episode group. These episode trigger codes are identifiable on Medicare claims in a patient's history and indicate the occurrence of the procedure. To enable meaningful clinical comparisons, episode groups may also be divided into more granular, mutually exclusive episode sub-groups based on clinical criteria (e.g., information available on the beneficiary's trigger claim), wherever appropriate. Episode sub-groups are useful in ensuring clinical comparability so that the corresponding cost measure fairly compares clinicians with a similar patient case-mix. Sub-groups must be balanced against the need to have an adequate number of cases that can be attributed to a clinician.

2.1.2 Process for Developing this Component

The Clinical Subcommittee reviewed the episode trigger codes originally listed in the December 2016 posting to inform the specifications for this episode group's definition. Through this process, Clinical Subcommittee members added and/or removed episode trigger codes through their independent review on the Clinical Input Tool (CIT). The CIT is a web-based tool developed by Acumen to allow stakeholders to provide clinical input on trigger refinement and service

assignment. The Clinical Subcommittee's input on episode triggers was summarized and shared with all members to inform discussions during an in-person meeting where the Clinical Subcommittee made recommendations on episode trigger codes based on group discussion and a subsequent vote. The Clinical Subcommittee also had the opportunity to refine the episode triggers further after considering stakeholder feedback collected during field testing.

For the episode sub-groups, Clinical Subcommittee members made preliminary suggestions during the in-person meeting on whether episode sub-groups were necessary and, if so, what potential sub-groups might be appropriate. Subsequently, Acumen worked with Subcommittee co-chairs to further examine these and other potential sub-groups by reviewing an analysis prepared by Acumen. Based on review of the analysis, the Subcommittee made recommendations on what potential sub-groups to put forth for a vote with the Subcommittee at large, and the Subcommittee also had the opportunity to refine their decisions on sub-groups after considering stakeholder feedback collected during field testing. The episode sub-groups identified for this episode group were determined through a poll of Subcommittee members.

2.1.3 Overview of Methodology for Episode Group Definition

Knee Arthroplasty episodes are triggered based on the occurrence of a trigger event. For a procedural episode group like the Knee Arthroplasty episode group, the trigger event is identified by the occurrence of a single Healthcare Common Procedure Coding System (HCPCS) / Current Procedural Terminology (CPT) code from a list of episode group trigger codes. For the Knee Arthroplasty episode group, episodes are also excluded based on other information available on the beneficiary's claims at the time of the trigger event. These trigger exclusions include bilateral partial knee arthroplasties and reinsertion/reimplantation of prosthetic knee after infection or spacer.

The episode group is then further divided into mutually exclusive episode sub-groups. For this cost measure, episode sub-groups are identified using information about the trigger procedure as well as any follow-up trigger procedure (to classify laterality). The episode sub-groups applied for the Knee Arthroplasty episode group are the following: (i) Total Knee / Bilateral, (ii) Total Knee / Unilateral, and (iii) Partial Knee / Unilateral. Table 2 below points to where additional information on the episode trigger codes and logic for the Knee Arthroplasty episode group can be found.

Table 2. Medical Codes and Logic Used in the Episode Group Definition

Medical Codes	Logic
<p>The "Measure Codes List - Knee Arthroplasty" file contains further information on the specific codes</p> <ul style="list-style-type: none"> • "Triggers" tab for trigger codes • "Trigger_Exclusions" tab for trigger exclusions codes • "Sub_Groups" tab for sub-group codes 	<ul style="list-style-type: none"> • Section 3.1, Step 1.1 contains information on how the episodes are triggered • Section 3.1, Step 1.2 contains information on how the episodes are excluded • Section 3.1, Step 1.3 contains information on how episode sub-groups are identified

2.2 Attribution of the Episode Group to Clinicians

The second component of a cost measure is attribution: the assignment of responsibility for episode costs.

2.2.1 Description of this Component

Episodes are attributed to a clinician based on the trigger event, and the attributed clinician is held responsible for the assigned costs of care during the episode window. Information from claims (i.e., services billed on the claim) are used to identify the clinician being considered for attribution.

Future attribution rules may also benefit from the implementation of patient relationship categories and codes. In April 2016, CMS posted a draft list of patient relationship categories for public comment, followed by the posting of a modified list for comment in December 2016 and an operational list in May 2017.¹⁸ Beginning January 1, 2018, clinicians may voluntarily report their patient relationships on claims. As required by section 101(f) of MACRA, CMS will consider how to incorporate the patient relationship categories into episode-based cost measurement methodology as clinicians and billing experts gain experience with them. During the voluntary reporting period, CMS will collect data on the use and submission of the patient relationship codes for validity and reliability testing before considering their potential future use in the attribution methodology for MIPS cost measures. Patient relationship categories and codes were not utilized during the development of this measure but may be used in conjunction with other claims-based attribution rules in the future.

2.2.2 Process for Developing for this Component

As a part of defining the episode group (Section 2.1 above), Clinical Subcommittee members were encouraged to consider which clinician(s) would likely be responsible for the costs and care during the episode when considering which episode trigger codes to select, given the types of clinicians who bill those codes. For procedural episode groups, the attributed clinician is the clinician billing the Part B Physician/Supplier (PB) claims for the service(s) provided during the trigger event.

2.2.3 Overview of the Methodology for Attribution

After episodes are opened, or triggered based on the occurrence of a trigger event (as described in Section 2.1.3), the attributed clinicians are determined using information from the trigger claims. Knee Arthroplasty episodes are attributed to the clinician(s) who bill the trigger services (defined by HCPCS/CPT procedure codes). Attributed clinicians are identified by a unique Taxpayer Identification Number and National Provider Identifier pair (TIN-NPI) informed by the “provider tax number” and “performing physician” fields on the PB claim. Table 3 below points to where additional information on the relevant codes and logic used in attribution for the Knee Arthroplasty episode group can be found.

¹⁸ CMS, “Patient Relationship Categories and Codes,” *MACRA Feedback Page*, <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/MACRA-Feedback.html>.

Table 3. Relevant Codes and Logic Used in Attribution

Relevant Codes	Logic
The “Measure Codes List - Knee Arthroplasty” file contains further information on codes relevant to attribution <ul style="list-style-type: none">• “Attribution” tab	<ul style="list-style-type: none">• Section 3.1, Step 2 contains information on how episodes are attributed

2.3 Assignment of Costs to the Episode Group

This sections describes the third component of episode-based cost measures: the assignment of costs (i.e., assignment of services) to the episode group.

2.3.1 Description of this Component

Services, and their respective Medicare costs, are assigned to the episode group if they are considered to be clinically related to the attributed clinician’s role in managing patient care during an episode. Assigned services might include diagnostic services, treatment services, and ancillary items and services directly related to treatment (such as anesthesia for a surgical procedure), as well as services following the initial treatment period that may be rendered to patients as follow-up care. Services furnished as a consequence of care, such as complications, readmissions, unplanned care, and emergency department visits may also be included. The episode group does not include clinically unrelated services, such as care for a chronic condition that occurs in the episode window for a procedure but is not related to the clinical management of the patient relative to the procedure.

2.3.2 Process for Developing this Component

To inform the specifications for the assignment of costs to the episode group, Clinical Subcommittee members reviewed an analysis of the utilization and timing of all Medicare Parts A and B services in broad timeframes extending before and after the episode trigger. These analyses were intended to inform the length of the pre-trigger and post-trigger periods for the episode window and Subcommittee members’ discussion on which services ought to be assigned to the episode group. For the episode window, the pre-trigger and post-trigger periods identified for this episode group were determined through a poll of Subcommittee members.

Next, Acumen clinicians operationalized the Clinical Subcommittee members’ service assignment feedback by reviewing a set of candidate service and diagnosis codes in the CIT and determining which ones to assign as episode costs. To focus the review of candidate codes in the CIT on those that make up a sufficiently large share of Medicare costs, the Acumen team implemented a cost threshold to eliminate infrequently occurring services and diagnoses. The draft service assignment rules were then shared with Subcommittee members via the CIT for their review and feedback. Once Subcommittee members reviewed the Acumen clinicians’ draft service assignment rules, their clinical input (i.e., agreements and disagreements with the draft rules) was summarized and reviewed by Acumen. During a follow-up webinar, Acumen clinicians asked targeted follow-up questions to Subcommittee members on topics where further discussion was needed. Acumen clinicians then used the input from this webinar to create the draft service assignment rules for the episode group.

The draft service assignment rules were used to determine episode costs for the Field Test Reports. After field testing, the Clinical Subcommittee had the opportunity to refine their decisions on service assignment rules and provide updated input after considering stakeholder feedback. Acumen clinicians used this refined input to finalize the service assignment rules for the episode

group. As a part of measure maintenance, service assignment rules will be revisited in the future to ensure the codes for assigned services are up-to-date and remain clinically relevant.

2.3.3 Overview of the Methodology for Assignment of Costs

For Knee Arthroplasty episodes, assigned services include: (i) assigned because it comprises the trigger event (i.e., services such as a triggering service on the trigger claim as well as the concurrent inpatient stay, if applicable, and its associated Part B Physician/Supplier and Durable Medical Equipment services), or (ii) assigned as a result of a service assignment rule derived from the process described above in Section 2.3.2. The service assignment rules were based on a set of service assignment rule options that are described below in Section 3.1, Step 3. In the pre-trigger period, this episode group has costs from certain items and services assigned from the Outpatient (OP) Facility and Clinician Services service category. In the post-trigger period, this episode group has costs from certain items and services assigned from the following categories: Emergency Room (ER); OP Facility and Clinician Services; Long-Term Care Hospital (LTCH) Medical; LTCH Surgical; Inpatient (IP) Medical; IP Surgical; Inpatient Rehabilitation Facility (IRF); Durable Medical Equipment, Prosthetics, Orthotics, and Supplies (DME); and Home Health (HH). For an attributed clinician's episode, all services occurring within the episode window are programmatically evaluated to determine whether their costs are assigned to the episode based on the service assignment rules.

The episode window for the Knee Arthroplasty episode group includes a pre-trigger period that spans 30 days before the trigger date and includes a post-trigger period that spans 90 days after the trigger date. Table 4 below points to where additional information on the service assignment rules and logic for the Knee Arthroplasty episode group can be found.

Table 4. Further Information on Service Assignment Rules and Logic

Service Assignment Rules	Service Assignment Logic
<p>The “Measure Codes List - Knee Arthroplasty” file contains further information on the specific codes assigned to the episode group, broken down by specific setting. The following tabs list relevant services assigned in during the episode window:</p> <ul style="list-style-type: none"> • “SA_Pre_<i>[Service_Category]</i>” tabs indicate services assigned in the pre-trigger period for various service categories/settings as listed in Section 2.3.3 • “SA_Post_<i>[Service_Category]</i>” tabs indicate services assigned in the pre-trigger period for various service categories/settings as listed in Section 2.3.3 	<ul style="list-style-type: none"> • Section 3.1, Step 3 contains information on how services are assigned to episode costs

2.4 Risk Adjustment

This section describes the fourth component of episode-based cost measures: risk adjustment.

2.4.1 Description of this Component

Risk adjustment aims to facilitate a more accurate comparison of cost across clinicians by adjusting for factors outside of the clinician's control that can influence spending. Some examples of factors that risk adjustment is intended to address include a beneficiary's age and comorbidities. Risk adjustment aims to isolate the variation in clinicians' costs to Medicare to those costs that clinicians can reasonably influence. Accounting for these factors is one way to ensure the validity of cost measures and mitigate against potential unintended consequences.

Similarly, certain patients or episodes with particular clinical characteristics may be excluded from episode-based cost measure calculation altogether. Exclusions remove a small, unique group of patients from cost measure calculation in cases where it may be both impractical and unfair to compare the costs of caring for these patients to the costs of caring for the cohort at large. Exclusions, like risk adjustment, help improve the validity of the cost measure by removing sources of variation outside of clinician control and prevent unintended consequences of measuring clinician cost performance when treating unique patient populations.

2.4.2 Process for Developing this Component

Acumen received broad feedback on risk adjustment used in episode-based cost measure calculation during the August 2017 TEP meeting. Acumen solicited TEP feedback on the proposed approach and materials used to gather Clinical Subcommittee input on risk adjustment and incorporated that feedback into the materials provided to the Clinical Subcommittees. Other recommendations gathered during the risk adjustment TEP will be evaluated by CMS and considered in future waves of episode-based cost measure development.

Acumen then gathered specific feedback from the Clinical Subcommittee on the clinical characteristics of patients that could be used in measure calculation as the basis for risk adjustors or measure exclusions. Clinical Subcommittee members were first introduced to the goals of risk adjustment and exclusions during a webinar. Subcommittee members were also provided an analysis of Medicare claims specific to the measure to help identify which services and diagnoses occurring in the 90 days before an episode may predict high episode costs. Based on their review of this analysis as well as their clinical experience and expertise, Clinical Subcommittee members suggested clinical characteristics for consideration as risk adjustors or exclusions for the cost measure. Clinical Subcommittee members shared their recommendations on the risk adjustment and exclusion specifications through a poll. The Clinical Subcommittee also had the opportunity to refine risk adjustors and measure exclusions further after considering stakeholder feedback collected during field testing.

2.4.3 Overview of the Methodology for Risk Adjustment

After services and their respective costs are assigned to the episode group, episode exclusion and risk adjustment are performed. The default "lookback" period, the time over which a beneficiary's Medicare claims history is reviewed to inform certain exclusion criteria and risk adjustment, is 120 days prior to the episode trigger day. If an episode meets exclusion criteria for the measure, the episode is removed from the population of episodes. These exclusion criteria include both the exclusions used to remove episodes for all procedural episode groups and the specific exclusions developed based on recommendations from the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee. Expected costs for each episode are then calculated through risk adjustment by taking into account variables that are included in the CMS Hierarchical Condition Category Version 22 (CMS-HCC V22) 2016 Risk Adjustment Model as well as additional risk adjustors that were recommended by the Clinical Subcommittee for

inclusion in the measure's risk adjustment model. Risk adjustment is performed separately for episodes within each sub-group.

Once expected costs are determined, the cost measure is calculated by taking (i) the sum of the ratio of observed to expected cost to Medicare for all episodes attributed to a clinician, and (ii) dividing that sum by the total number of episodes attributed to the clinician. The result is then multiplied by the national average observed episode cost to generate a dollar figure representing risk-adjusted average episode costs. Table 5 below points to where additional information on the risk adjustors and exclusions for the Knee Arthroplasty cost measure can be found.

Table 5. Further Information on Codes and Logic for Risk Adjustors and Exclusions

Risk Adjustors and Exclusions Codes	Risk Adjustment and Exclusions Logic
<p>The "Measure Codes List - Knee Arthroplasty" file contains further information on specific codes used in risk adjustment and exclusions</p> <ul style="list-style-type: none"> • "RA_Vars" tab for risk adjustment variables • "RA_Vars_Details" tab for details on the codes used to define risk adjustors constructed based on Clinical Subcommittee recommendations • "Exclusions" tab for exclusions and their codes • "Exclusions_Details" tab for details on the codes used to define exclusions constructed based on Clinical Subcommittee recommendations 	<ul style="list-style-type: none"> • Section 3.2, Step 5 contains information on the logic related to exclusions • Section 3.2, Step 6.1 contains information on the logic related to risk adjustment

2.5 Alignment of Cost with Quality

This section describes the fifth and final component of episode-based cost measures: the alignment of cost with quality.

2.5.1 Description of this Component

This component involves the consideration of how to align cost measure performance with quality measures. Such quality measures include outcomes, processes of care, and patient engagement and experience. These quality measures need to be considered along with cost measures to ensure that clinicians throughout a patient's care trajectory are incentivized to provide high-value, patient-centered care, with the goal of mitigating potential unintended consequences. For instance, pairing cost measure performance with quality measures that share similar characteristics would allow for patient outcomes such as functional status and mortality to be interpreted alongside with cost.

2.5.2 Process for Developing this Component

To assist with the approach for aligning cost and quality, Acumen provided Clinical Subcommittee members with quality alignment reports at the beginning of measure development activities in May 2017. These reports listed all procedural and acute inpatient medical condition episode groups within each Clinical Subcommittee's clinical area based on the draft list of episode groups and episode trigger codes from the December 2016 posting. The

report then detailed which episode groups had potential to align with existing quality measures in the Quality Payment Program.

Members were able to refer to these reports and analyses, as well as stakeholder feedback from field testing, to inform their input throughout the measure development process. For instance, the Clinical Subcommittees could use the alignment reports to consider the potential of episode groups to align with quality measures as a factor when selecting which episode group to develop. Members could also reference the detailed information about the specifications of a quality measure's patient cohort while making their recommendations on episode trigger codes for the episode-based cost measures.

3.0 Detailed Measure Methodology

Section 3 expands upon the description measure development processes and the overview of the measure methodology explained in Section 2 by providing detailed technical information on the specifications for the Knee Arthroplasty cost measure methodology.

There are two overarching processes in calculating episode-based cost measure scores: episode construction and measure calculation. Episode construction includes both the steps involved in building episodes (the “unit of analysis” for measuring costs) by applying an episode grouping algorithm to claims data and the steps to sum costs for each episode. Measure calculation includes estimating expected episode costs through a risk adjustment model that accounts for patient complexity, and computing measure scores for each TIN or TIN-NPI. Episode construction steps are detailed in Section 3.1 below. Measure calculation steps are detailed in Section 3.2.

3.1 Steps in Episode Construction

Knee Arthroplasty episodes are based on the occurrence of this procedure and include clinically related services in episode costs. Episode construction for Knee Arthroplasty episodes consists of three components: episode group definition, clinician attribution, and episode group cost assignment. This section describes the logic steps involved in specifying each component in turn.

Step 1: Defining Episodes

1.1: Trigger Episodes

Knee Arthroplasty episodes are triggered by Part B (PB) claims in which trigger procedure codes indicating occurrence of a procedure are billed, as listed in the “Triggers” tab of the Knee Arthroplasty Measure Codes List file. To identify these claims, the following steps are performed:

- (1) Identify claims with positive standardized payment that have a trigger code.
- (2) If all of the conditions below are met for a claim line with a trigger code, trigger an episode.
 - (a) It is the highest cost claim line across any Knee Arthroplasty trigger code billed for the beneficiary on that day.
 - (b) It was billed by a physician, physician assistant, nurse practitioner, clinical nurse specialist, certified registered nurse anesthetist, or a clinician group.
 - (c) It does not have a post-operative modifier code.
- (3) Flag episodes that have a concurrent Inpatient (IP) stay by identifying the first IP stay (with relevant DRGs and logic as listed in the “Trigger_Exclusions” tab of the Measure Codes List - Knee Arthroplasty file) for a beneficiary that is concurrent to the expense date for the trigger PB claim line.
- (4) Determine the episode trigger date, episode start date, and episode end date as follows:
 - (a) Establish the episode trigger day as the date of admission if an IP stay with a relevant DRG concurrent with trigger is found, otherwise the expense date of the PB claim line for the episode trigger code.

- (b) Establish the episode start date as 30 days prior to the episode trigger day.
- (c) Establish the episode end date as 90 days from the episode trigger day.

1.2: Exclude Episodes

After episodes are triggered, certain episodes are excluded based on information from the trigger event (if an IP stay concurrent to trigger is found) or the trigger PB claim (if no IP stay concurrent to trigger is found). For episodes where an IP stay concurrent to the trigger PB claim line is found, the trigger event includes the IP stay along with all PB and Outpatient (OP) claims occurring during the IP stay. Trigger exclusions were developed with input from the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee and can be found in the “Trigger_Exclusions” tab of the Knee Arthroplasty Measure Codes List file. Additional episode exclusions are described in Step 5 of Section 3.2.

- (5) Define trigger exclusions for the episode group using information from one or more of the following:
 - (a) MS-DRG and ICD-10 procedure codes from the IP stay concurrent with trigger, if found, and HCPCS/CPT codes on Part B and Outpatient claims during that IP stay
- (6) Exclude episodes with a concurrent IP stay that were flagged in item (3) based on the MS-DRGs listed in the “Trigger_Exclusions” tab of the Knee Arthroplasty Measure Codes List file.

1.3: Identify Sub-groups

Once Knee Arthroplasty episodes are triggered, the episode group is divided into more granular mutually exclusive episode sub-groups based on clinical criteria developed by the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee. Dividing episode groups into sub-groups ensures meaningful clinical comparisons. There are 3 sub-groups in the Knee Arthroplasty episode group:

- Total Knee / Bilateral
- Total Knee / Unilateral
- Partial Knee / Unilateral

Codes used to define Knee Arthroplasty episode sub-groups are listed in the “Sub-Groups” tab of the Knee Arthroplasty Measure Codes List file.

- (7) Define Knee Arthroplasty sub-groups using information from the following:
 - (a) The HCPCS/CPT procedure on the trigger PB claim line

In addition, Knee Arthroplasty episode groups have sub-groups defined by laterality of the procedure. Modifier codes used to define laterality are listed in the “Sub-Groups” tab of the Knee Arthroplasty Measure Codes List file.

- (8) Assign laterality according to the following:
 - (a) Establish a unilateral sub-group if the episode has a right, left, or no bilateral modifier code on the episode trigger day.
 - (b) Establish a bilateral sub-group if one of the following conditions is true:
 - (i) The episode has a bilateral modifier code on the episode trigger claim.
 - (ii) The episode’s trigger claim has a right (or left) modifier code followed by another Knee Arthroplasty episode with an opposite left (or right) modifier code

on a subsequent trigger claim within 90 days. In these staged laterality events, the two episodes will be combined to one.

Step 2: Attributing Episodes to Clinicians

Once episodes are defined, episodes are attributed to the MIPS eligible clinician(s) based on whether the clinician billed a Knee Arthroplasty trigger code on the episode trigger day. Clinicians are identified as TIN and NPI pairs (TIN-NPI). A TIN identifies a clinician group. The following steps are performed to attribute episodes to clinicians:

- (9) Identify claim lines with positive standardized payment for any Knee Arthroplasty trigger code that occurs on the episode trigger day.
- (10) Designate each TIN-NPI as the main clinician if both of the following conditions are true for one or more claim lines billed by the TIN-NPI from item (9):
 - (a) No assistant modifier code (as listed in the “Attribution” tab of the Knee Arthroplasty Measure Codes List file) is found.
 - (b) No exclusion modifier code (as listed in the “Attribution” tab of the Knee Arthroplasty Measure Codes List file) is found on the same claim line as in item (10)(a).
- (11) If the TIN-NPI was not designated as a main clinician in item (10), designate the TIN-NPI as the assistant clinician if all of the following conditions are true for one or more claim lines billed by the TIN-NPI from item (10):
 - (a) One of the assistant modifier codes (as listed in the “Attribution” tab of the Knee Arthroplasty Measure Codes List file) is found.
 - (b) No exclusion modifier code (as listed in the “Attribution” tab of the Knee Arthroplasty Measure Codes List file) is found on the same claim line as in (11)(a).
- (12) Attribute a Knee Arthroplasty episode to a TIN-NPI if both of the following are true:
 - (a) The TIN-NPI was designated as a main or assistant clinician through item (10) or (11) above.
 - (b) At least one of the claim lines billed by the TIN-NPI for an episode trigger code on the episode trigger day meets all the following conditions:
 - (i) It was billed by an eligible clinician listed in the “Attribution” tab of the Knee Arthroplasty Measure Codes List file.
 - (ii) It does not have a post-operative modifier code.
- (13) Attribute an episode to a TIN by aggregating all episodes attributed to the NPIs that bill to that TIN. If the same episode is attributed to more than one NPI within a TIN, this episode is only attributed to the TIN once.

Step 3: Assigning Costs to the Episode Group

Once Knee Arthroplasty episodes are defined and episodes are attributed to clinicians, clinically related items and services are assigned to each episode during the episode window. Service assignment rules were developed with input by the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee, which provided guidance on what should be counted toward Knee Arthroplasty episodes. Section 2.3 provides a description of the development process for

this component of the cost measure. Service assignment rules referenced in item (16) are listed in the “SA_*[Service_Category]*” tabs of the Knee Arthroplasty Measure Codes List file.

- (14) Identify all claims with positive standardized payment that occur within the episode window.
- (15) Assign costs for the IP stay concurrent with trigger, if found, and all PB claim lines and DME services that occur during this IP stay. Otherwise, assign costs for the trigger PB claim line only.
- (16) Organize claims into the service categories and time periods described in Table 6 below. The last two columns indicate whether any services were assigned in each service category during a pre- or post-trigger period. “Yes” indicates that services were assigned in the given service category, and “No” indicates that no services in the given service category were assigned for the given time period.

Table 6. Service Categories Considered in Service Assignment

Service Category	Description	Pre-Trigger	Post-Trigger
IP - Medical	Inpatient medical services, classified by Base Diagnosis Related Groups (DRGs). Base DRGs combine without major complication or comorbidity/complication or comorbidity (“w/o MCC/CC”), “w/CC,” and “w/MCC” Medicare Severity DRGs (MS-DRGs).	No	Yes
IP - Surgical	Inpatient surgical services, classified by Surgical Base DRGs and ICD-10 procedure codes. Base DRGs combine “w/o MCC/CC,” “w/CC,” and “w/MCC” MS-DRGs.	No	Yes
IRF - Medical	Inpatient rehabilitation facility services, classified by Rehabilitation Impairment Categories (RICs).	No	Yes
LTCH - Medical	Long term care hospital medical services, classified by medical Base DRGs. Base DRGs combine “w/o MCC/CC,” “w/CC,” and “w/MCC” MS-DRGs.	No	Yes
LTCH - Surgical	Long term care hospital surgical services, classified by surgical Base DRGs and ICD-10 procedure codes. Base DRGs combine “w/o MCC/CC,” “w/CC,” and “w/MCC” MS-DRGs.	No	Yes
HH	Home health services, classified according to 3-digit revenue center code representing home health service or visit type.	No	Yes
OP Facility and Clinician Services	Outpatient and Carrier (i.e., Physician/Supplier) Part B services, classified by Clinical Classification Software (CCS) categories and HCPCS/CPT procedure codes.	Yes	Yes
ER	Outpatient emergency room services classified by the diagnoses found on ER evaluation and management (E&M) HCPCS/CPT procedure codes.	No	Yes
DME	Durable medical equipment, prosthetics, orthotics, and supplies classified by HCPCS/CPT procedure codes.	No	Yes

- (17) Assign services to the episode according to a series of service assignment rules.
 - (a) A service assignment rule can be based on the incidence of a service code alone, or the incidence of a service code combined with additional service and diagnosis

information. The following outlines alternatives for the basis of a service assignment rule:

- (i) Service code alone
 - (ii) Service code and the first three digits of the International Classification of Diseases – Tenth Revision diagnosis code (3-digit ICD-10 DGN)
 - (iii) Service code and the full ICD-10 DGN
 - (iv) Service code and additional service information
 - (v) Service code, additional service information, and the 3-digit ICD-10 DGN
 - (vi) Service code, additional service information, and the full ICD-10 DGN
- (b) Service codes and additional service information considered in service assignment rules vary based on service category, according to the following table:

Table 7. Information Considered in Service Assignment Rules by Service Category

Service Category ¹⁹	Service Code Considered in Assignment Rules	Additional Service Information Considered in Assignment Rules
IP - Medical	Base DRG	N/A
IP - Surgical	Base DRG	ICD-10 Procedure Codes
IRF - Medical	RIC	N/A
LTCH - Medical	Base DRG	N/A
LTCH - Surgical	Base DRG	ICD-10 Procedure Codes
HH	3-Digit Revenue Center Code	N/A
OP Facility and Clinician Services	CCS	HCPCS/CPT
ER	E&M HCPCS/CPT	N/A
DME	HCPCS/CPT	N/A

- (c) Based on one of the levels of information outlined in (17)(a), one of the following assignment rules is applied for each service in the episode window:
- (i) Assign the service
 - (ii) Do not assign the service
 - (iii) Assign the service based on one of the following rules:
 - 1) Assign if the 3-digit ICD-10 DGN is newly occurring
 - 2) Assign if the service code is newly occurring
 - 3) Assign if the service code and the 3-digit ICD-10 DGN are newly occurring
 - 4) Assign if the service code and the full ICD-10 DGN are newly occurring
 - 5) Assign if the service code or the 3-digit ICD-10 DGN is newly occurring

¹⁹ Where applicable, based on the service categories that have services assigned for this episode group as identified in the last two columns of Table 6, above.

- 6) Assign if the service code or the full ICD-10 DGN is newly occurring
- (18) Identify Skilled Nursing Facility (SNF) claims for which both of the following conditions are true:
 - (a) The SNF claim occurs during the episode window.
 - (b) The SNF claim has a qualifying IP stay that is assigned according to the rules described above.
- (19) For all SNF claims identified in step (18), assign the percentage of the claim amount proportional to the portion of the SNF claim that overlapped with the episode window.

Step 4: Calculating Standardized Observed Episode Costs

This step involves calculating observed episode cost. Observed costs represent the total standardized amount paid to Medicare providers for all services assigned to each episode.

- (20) Sum standardized Medicare allowed amounts for all services assigned to each episode.

3.2 Steps in Measure Calculation

Measure calculation begins with the episodes constructed from Steps 1-3 in Section 3.1 and incorporates risk adjustment, the fourth component of episode-based cost measures, to ensure that the measure accounts for the complexity of clinicians' patients. Specifically, once Knee Arthroplasty episodes are constructed, measure calculation involves: excluding episodes for unique patient populations that are not clinically comparable, estimating the expected costs for each episode while accounting for patients' comorbidities and other factors via a risk adjustment model, and finally, calculating the measure for each TIN or TIN-NPI based on their average risk-adjusted episode costs.

Step 5: Excluding Episodes

Before measure calculation can occur, a series of episode exclusions are applied to remove certain episodes from being used in calculating a TIN or TIN-NPI's measure score. This section describes criteria used to exclude episodes for the Knee Arthroplasty measure, including exclusions applied across all procedural episode groups as well as exclusions specific to Knee Arthroplasty. The latter exclusions were developed with input from the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee following the process outlined in Section 2.4.2.

- (21) Knee Arthroplasty episodes are excluded if they meet any of the following criteria:
 - (a) The beneficiary has a primary payer other than Medicare for any amount of time overlapping the episode window or in the 120 days prior to the episode trigger day.
 - (b) No attributed clinician is found for the episode.
 - (c) The beneficiary's date of birth is missing.
 - (d) The beneficiary's death date occurred before the trigger date.
 - (e) The beneficiary's death date occurred before the episode ended.
 - (f) The beneficiary was not enrolled in Medicare Part A and B for the entirety of the 120-day lookback period plus episode window, or is enrolled in Part C for any part of the lookback period plus episode window.

- (g) The IP facility is not one that is paid under the Inpatient Prospective Payment System (IPPS) when an IP stay concurrent with trigger is found.²⁰
 - (h) The episode trigger claim was not performed in an office, IP, OP, or ASC setting based on its place of service.
- (22) Knee Arthroplasty episodes are also removed using exclusions specific to the Knee Arthroplasty measure that were developed with input from the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee. The “Exclusions” and “Exclusions_Details” tabs in the Knee Arthroplasty Measure Codes List file include the list of these exclusions as well as the codes used to define them. Each exclusion checks the beneficiary’s Medicare claims history within the 120 days prior to the episode trigger for one or more of the following:
- (a) IP stays with particular ICD-10 DGNs and/or ICD-10 procedure codes
 - (b) PB claim lines with particular HCPCS/CPT procedures and/or ICD-10 DGNs
 - (c) OP claim lines with particular HCPCS/CPT procedures and/or ICD-10 DGNs

Step 6: Calculate Expected Episode Costs through Risk Adjustment

This step calculates expected costs for each episode, as predicted through a risk adjustment model that uses a linear regression. To account for the limitations of risk adjustment, episodes predicted to have expected costs that are substantially different from observed costs are excluded as outliers. This step is performed separately for each sub-group.

6.1: Estimate Risk Adjustment Model

The linear regression model includes independent variables such as HCCs as well as variables that were recommended by the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee for this measure. See the “RA_Vars” and “RA_Vars_Details” tabs of the Knee Arthroplasty Measure Codes List file for a complete list of risk adjustors.

- (23) Define HCC and episode group-specific risk adjustors using service and diagnosis information found on the beneficiary’s Medicare claims history within the 120 days prior to the episode trigger day for one or more of the following:
 - (a) IP stays with particular ICD-10 DGNs
 - (b) PB claims with particular ICD-10 DGNs
 - (c) OP claims with particular ICD-10 DGNs
- (24) Define other risk adjustors that rely upon Medicare beneficiary enrollment and assessment data as follows:
 - (a) Identify beneficiaries who are originally “Disabled without end-stage renal disease (ESRD)” or “Disabled with ESRD” using the original reason for joining Medicare field in the Medicare beneficiary enrollment database.

²⁰ Only stays at IP facilities that are paid under IPPS (i.e., that are subsection (d) hospitals) will be included. Subsection (d) hospitals are hospitals in the 50 States and D.C. other than: psychiatric hospitals, rehabilitation hospitals, hospitals whose inpatients are predominantly under 18 years old, hospitals whose average inpatient length of stay exceeds 25 days, and hospitals involved extensively in treatment for or research on cancer.

- (b) Identify beneficiaries with ESRD if their enrollment indicates ESRD coverage, ESRD dialysis, or kidney transplant in the Medicare beneficiary enrollment database in the 120 days before and including the episode trigger day.
- (c) Identify beneficiaries who reside in a long-term care institution as of the episode trigger day using Minimum Dataset (MDS) assessment data.
- (25) Determine the number of episodes with each independent variable defined in items (23) and (24) included in a regression, and drop risk adjustors that are defined for less than 15 episodes nationally.
- (26) Categorize beneficiaries into age ranges using their date of birth information in the Medicare beneficiary enrollment database. If an age range has a cell count less than 15, then collapse it with the next adjacent higher age range category.
- (27) Include the MS-DRG of the episode's trigger IP stay as a categorical risk adjustor.
- (28) Use an ordinary least squares (OLS) regression to estimate the relationship between the independent variables listed in the "RA_Vars" tab of the Knee Arthroplasty Measure Codes List file and the dependent variable, standardized observed episode costs. A separate regression is run for each episode sub-group.

6.2: Winsorize

Winsorization aims to limit the effects of extreme values on expected costs. Winsorization is a statistical transformation that limits extreme values in data to reduce the effect of possible outliers. Winsorization of the lower end of the distribution (i.e., bottom coding) involves setting extremely low predicted values below a predetermined limit to be equal to that predetermined limit.

- (29) For expected episode costs below the 0.5th percentile, assign the value of the 0.5th percentile.
- (30) Renormalize²¹ values by multiplying each episode's winsorized expected cost by the sub-group's average expected cost, and dividing the resultant value by the sub-group's average winsorized expected cost.

6.3: Exclude Outlier Episodes

This step excludes episodes based on outlier residual values from the calculation and renormalizes the resultant values to maintain a consistent average episode cost level. This step is performed separately for each sub-group.

- (31) Calculate each sub-group's residual as the difference between the re-normalized, winsorized expected cost computed in item (30) above and the observed cost.
- (32) Exclude episodes with residuals below the 1st percentile or above the 99th percentile of the residual distribution.
- (33) Renormalize the resultant expected cost values by multiplying by the sub-group's average observed cost and dividing by the sub-group's average re-normalized, winsorized expected cost.

Step 7: Calculate Measure Scores

²¹ Renormalization is performed after adjustments are made to the episode's expected cost, such as bottom-coding or residual outlier exclusion. This process multiplies the adjusted values by a scalar ratio to ensure that the resulting average is equal to the average of the original value.

The cost measure score is calculated for each TIN-NPI (clinician) or TIN (clinician group practice) according to the following steps:

- (34) Calculate the measure score as the average ratio of observed cost to expected episode cost across a provider's episodes, multiplied by the national average observed episode cost. This calculation is done using episodes from all sub-groups. Mathematically, the clinician- or clinician-group-practice-level risk-adjusted cost for clinician/clinician group practice j is:

$$Measure\ Score_j = \left(\frac{1}{n_j} \sum_{i \in I_j} \frac{Y_{ij}}{\hat{Y}_{ij}} \right) \left(\frac{1}{n} \sum_j \sum_{i \in \{I_j\}} Y_{ij} \right)$$

where:

Y_{ij}	is the attributed standardized payment for episode i and clinician (or clinician group practice) j
\hat{Y}_{ij}	is the expected standardized payment for episode i and clinician (or clinician group practice) j , as predicted from risk adjustment
n_j	is the number of episodes for clinician (or clinician group practice) j
n	is the total number of episodes nationally
$i \in \{I_j\}$	is all episodes i in the set of episodes attributed to clinician (or clinician group practice) j

Appendices

Appendix A

Table A-1 below lists the members of the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee along with their specialty, city, and state. Asterisks (*) denote the Clinical Subcommittee co-chairs.²²

Table A-1. Composition of the Musculoskeletal Disease Management - Non-Spine Clinical Subcommittee

Name and Credentials	Specialty	City, State
Adam Rana, MD	Orthopedic Surgery	Falmouth, ME
*Adolph Yates, MD	Orthopedic Surgery	Pittsburgh, PA
Alex Limanni, MD	Rheumatology	Dallas, TX
Ammar Sarwar, MD	Interventional Radiology	Boston, MA
Andrew Gordon, MD, PhD	Physical Medicine and Rehabilitation	Silver Spring, MD
Bela Pandit, DPM, FACFAS	Podiatry	Chicago, IL
Daniel Moon, MD, MS, MBA	Orthopedic Surgery	Aurora, CO
Daniel Wessell, MD	Diagnostic Radiology	Jacksonville, FL
David Friedenson, MD	Emergency Medicine	Denver, CO
Dennis Rivenburgh, MS, ATC, PA-C, DFAAPA	Physician Assistant	Baltimore, MD
Dheeraj Mahajan, MD, CMD, FACP	Internal Medicine	Melrose Park, IL
Edward Mariano, MD, MAS	Anesthesiology	Palo Alto, CA
Heather Smith, PT, MPH	Physical Therapy	Alexandria, VA
Jennifer Koontz, MD, MPH, FAAFP	Sports Medicine	Newton, KS
Jeremy Furniss, OTD, OTR/L, BCG, CDP	Occupational Therapy	Bethesda, MD
*Juan Quintana, DNAP, MHS, CRNA	Certified Registered Nurse Anesthetist	Winnsboro, TX
Kenneth Hunt, MD	Orthopedic Surgery	Aurora, CO
Kevin Klauer, DO, EJD, FACEP	Emergency Medicine	Knoxville, TN
Kirk Whetstone, MD	Physical Medicine and Rehabilitation	Columbus, OH
Marc DeHart, MD	Orthopedic Surgery	San Antonio, TX
Mark Levine, MD	Internal Medicine	Aurora, CO
Michael DePalma, PA-C	Orthopedic Surgery	Hanover, PA
Michael Wasserman, MD	Geriatric Medicine	Woodland Hills, CA
Michael Zychowicz, DNP	Orthopedic Surgery	Durham, NC
Robert (Dale) Blasier, MD, FRCS, MBA	Orthopedic Surgery	Little Rock, AR
Robin Kamal, MD	Hand Surgery	Palo Alto, CA
Steven Schmitt, MD	Infectious Disease	Cleveland, OH
William Beach, MD	Orthopedic Surgery	Richmond, VA

²² Co-chairs facilitated discussion and assisted in reaching consensus on cost measure development recommendations during Clinical Subcommittee meetings, webinars, and activities.

Appendix B

Table B-1 below lists the changes to this measure made since the Draft Cost Measure Methodology and Draft Measure Codes List were posted in October 2017. These changes reflect further refinement of the measure after the Clinical Subcommittee considered feedback from the field testing period in October – November 2017.

Table B-1. Changes to the Knee Arthroplasty Cost Measure Following Field Testing

Type of Change	Change
Triggers	N/A
Sub-Groups	N/A
Measure-Specific Exclusions	Add exclusion for revisions and spacers
Attribution	N/A
Service Assignment	<p>Pre-Trigger Services: Remove following types of pre-op services:</p> <ul style="list-style-type: none"> - Cardiac Cath - Cardiac Stress Test - Nuclear Stress Test - Pulmonary Testing <p>Post-Trigger Services: - Change post-trigger window for UTI from <30 days to <15 days - Add all HCPCS within CCS 213 and 215</p>
Risk Adjustment	N/A
Other	N/A