Robert Bree
Collaborative

Warranty for Elective Total Knee & Total Hip Replacement Surgery

In developing this warranty the Accountable Payment Model (APM) subgroup of the Dr. Robert Bree Collaborative relied most heavily on a technical expert panel study of complications of total knee and total hip replacement (TKR and THR) surgery commissioned by the Centers for Medicare and Medicaid Services (CMS) (referred to as the 'CMS TEP report' in this document).[i] We also aligned with the High Value Healthcare Collaborative (HVHC), a group of 18 major medical systems from across the country founded by the Dartmouth Institute for Health Policy and Clinical Practice (TDI), Dartmouth-Hitchcock, Mayo Clinic, Denver Health, Intermountain Healthcare, and Cleveland Clinic, to improve quality for these surgeries. We studied private sector data from our market place and bundled payment initiatives from the Integrated Healthcare Association in California, from Meriter Health Plan in Wisconsin, and the CMS bundled payment initiative.[ii]

The primary intent of the warranty is to set a high priority on patient safety. It is also intended to balance financial gain for providers and institutions performing TKR and THR surgery with financial accountability for complications attributable to these procedures. In this warranty the intent is to distribute financial risk across professional and facility components in proportion to the revenue generated by the procedure.

Definitions related to a warranty for TKR and THR

- Diagnostic code for osteoarthritis - excludes trauma, cancer, inflammatory arthritis (e.g. rheumatoid arthritis) and congenital malformation
- Procedural codes for TKR and THR
- Age limits
- Definition of complications excluded from additional reimbursement
- Definition of warranty period

Diagnostic codes[1]

The diagnostic code for osteoarthritis for either total knee or total hip replacements:
ICD-9 diagnostic code = 715.X ("715 Osteoarthrosis and allied disorders")[2]

Procedure codes[3]

- Total hip replacement: ICD-9 procedure code = 81.51 (CPT procedure code = 27130 (total hip replacement)
- Total knee replacement: Associated ICD-9 procedure code = 81.54 (CPT procedure code = 27447 (total knee replacement)

Age limits[4]

>=18 years old (no upper limit)

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[1] Same as HVHC, IHA, and Meriter Health Plan TKR and THR bundle.
[2] 89% of all Total Hip Replacement (81.51) in Washington State were due to some type of principal diagnosis of Osteoarthrosis (Data Source: CHARS, 2012 1st Quarter, 2011 4th Quarter, 2011 3rd Quarter, 2011 2nd Quarter); 97% of all Total Knee Replacement (81.54) in Washington State were due to some type of principal diagnosis of Osteoarthrosis (Data Source: CHARS, 2012 1st Quarter, 2011 4th Quarter, 2011 3rd Quarter, 2011 2nd Quarter).
[3] Same as HVHC, IHA, and Meriter Health Plan TKR and THR bundle.
[4] The APM subgroup chose no upper age limit on the basis that it is best to defer to surgeons for the decision of whether surgery is appropriate for an older patient. Both IHA and Meriter uses an age cut off of 65 years old; HVHC uses 89 years old; the CMS requires patient to be a Medicare beneficiary (no upper limit).

Complications[5]

Definition of complications included in warranty:

- As specified by CMS TEP report (*attached as an **appendix** to this warranty*)
- Aligned with ICD-9 codes adopted by HVHC

Complications for warranty are intended to meet the following criteria**:**

- Represent significant complications attributable to the THA/TKA procedure
- Are identifiable in administrative claims data
- Are fair to hospitals and physicians

1. Death as a result of any of the other complications included in the warranty
2. Surgical complications
   a. Mechanical complications
   b. Periprosthetic joint complications:
      - Incision and drainage
      - Revision
      - Removal
   c. Wound infection:
      - Incision and drainage
      - Revision
      - Removal
   d. Surgical site bleeding requiring readmission for incision and drainage
   e. Pulmonary embolism
3. Medical complications
   a. Acute myocardial infarction
   b. Pneumonia
   c. Sepsis/septicemia

[5] The APM subgroup agreed to adopt the complications list commissioned by CMS and adopted by HVHC. The APM subgroup also reviewed private payer utilization data on complications from TKR and THR produced and shared by payer subgroup members. Complications such as arrhythmia, congestive heart failure, and GI bleeding show up in private payer data analyses as complications but are omitted from HVHC list of complications. The APM subgroup agreed not to include these complications as they are not easily attributable to THR and TKR surgery.

Warranty period and other terms[6,iii]

1. Warranty period is complication-specific:

7 days	30 days	90 days
Acute myocardial infarction	Death	Mechanical complications
Pneumonia	Surgical site bleeding	Periprosthetic joint infection
Sepsis/septicemia	Wound infection	
	Pulmonary embolism	

2. The warranty is valid only at the hospital performing the surgery. Therefore, patients experiencing complications are strongly encouraged to seek treatment at that hospital.

[i] Summary of Technical Expert Panel (TEP) Evaluation of Measures: 30-Day Risk-Standardized Readmission Rate following Elective Total Hip and Total Knee Arthroplasty and Risk-Standardized Complication Rate following Elective Total Hip and Total Knee Arthroplasty. Prepared for CMS by Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation. July 19, 2010. Link: http://www.cch-quality.com/Files/CMS_Hip.Knee_SummaryReport_TEP_7-19-10_FINAL_Hip.TKA.pdf

[ii] Source material for definitions:

- High Value Health Care Collaborative - Ivan M. Tomek, Allison L. Sabel, Mark I. Froimson, George Muschler, David S. Jevsevar, Karl M. Koenig, David G. Lewallen, James M. Naessens, Lucy A. Savitz, James L. Westrich, William B. Weeks and James N. Weinstein. A Collaborative Of Leading Health Systems Finds Wide Variations In Total Knee Replacement Delivery And Takes Steps To Improve Value. *Health Affairs,* no. (2012): doi: 10.1377/hlthaff.2011.0935. (http://content.healthaffairs.org/content/early/2012/04/30/hlthaff.2011.0935.full.html)
- Integrated Healthcare Association, CA - (www.iha.org) and personal communication with IHA staff;
- Meriter Health Plan, WI – personal communication with staff; and
- CMS Bundled Payment for Care Improvement Initiative: http://innovation.cms.gov/initiatives/bundled-payments.

[iii] Ibid.

[6] The APM subgroup chose to adopt a warranty timeline model based on the study commissioned by CMS and adopted by HVHC. After reviewing Medicare and private payer data shared by payer subgroup members, the APM subgroup agreed that this model was preferred because it is specific, justified by the readmissions data, likely to capture procedure-related complications, protects purchasers, acceptable to providers, and endorsed by a highly respected group of orthopedists after a yearlong review process.

APPENDIX

Summary of Technical Expert Panel (TEP) Evaluation of Measures 30-Day Risk-Standardized Readmission Rate following Elective Total Hip and Total Knee Arthroplasty and Risk-Standardized Complication Rate following Elective Total Hip and Total Knee Arthroplasty

Summary of Technical Expert Panel (TEP) Evaluation of Measures

30-Day Risk-Standardized Readmission Rate following Elective Total Hip and Total Knee Arthroplasty
and
Risk-Standardized Complication Rate following Elective Total Hip and Total Knee Arthroplasty

Subtask 3.1, Deliverable 20b: Summary of Technical Expert Panel Evaluation of Measures

Submitted July 19, 2010:

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Contract Number: HHSM-500-2008-0025I-MIDS Task Order T0001

This material was prepared by Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (YNHHSC/CORE), under contract to the Centers for Medicare & Medicaid Services (CMS), an agency of the U.S. Department of Health and Human Services. The contents presented do not necessarily reflect CMS policy.

Table of Contents

Background

The Yale-New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (YNHHSC/CORE) is under contract with the Center for Medicare & Medicaid Services (CMS) to develop claims-based, risk adjusted hospital outcomes measures that reflect the quality of care for patients undergoing elective total hip arthroplasty (THA) and elective total knee arthroplasty (TKA). The measures are designed for potential use in public reporting.

YNHHSC/CORE has obtained expert and stakeholder input on two proposed measures: (1) a 30-day all-cause readmission measure and (2) a complications measure for patients undergoing elective THA and TKA. The Yale measure development team meets twice monthly via teleconference with a Working Group (WG) of experts in orthopaedic surgery, rheumatology, quality outcomes measurement, and measure development. Additionally, we convened a Technical Expert Panel (TEP) of clinicians, consumers, hospitals, purchasers, and experts in quality improvement to provide input on key methodological issues.

This report summarizes the feedback and recommendations provided by the TEP to date regarding the proposed measures. For each measure, details regarding overall approach, measure rationale, and preliminary technical specifications, will be available through CMS at https://www.cms.gov/MMS/17_CallforPublicComment.asp#TopOfPage through September 1, 2010 and will be available for public comment through August 4, 2010, 11:59 pm ET. This report is available as background for the public comment period. Of note, the measures remain in development, and the technical specifications will not be finalized until later this fall.

The YNHHSC/CORE Development Team

The YNHHSC/CORE new measure development team includes clinical, statistical, policy, and project management experts to provide a broad range of perspectives and expertise. The YNHHSC/CORE new measures development team participates in all discussions and facets of measure development. The team is led by Laura Grosso, PhD., Jeptha Curtis, MD, and Zhenqiu Lin, PhD. Dr. Grosso is an epidemiologist with training in research methodology. Dr. Curtis has extensive experience in developing new measures and led the development of two, NQF approved PCI mortality measures and two additional measures (ICD complications and PCI readmission) that are currently under review at the NQF. Dr. Lin is an expert in measure development using Medicare claims data. The YNHHSC/CORE new measures development team is listed below.

Jeptha Curtis, M.D.
Assistant Professor of Medicine, Yale University School of Medicine

Elizabeth Drye, M.D., S.M.
Associate Research Scientist, Yale University School of Medicine

Lori Geary, M.P.H.
Project Manager, YNHHSC/CORE

Laura M. Grosso, Ph.D., M.P.H.
Associate Research Scientist, Yale University School of Medicine

Linda Harris, M.P.H.
Project Coordinator, YNHHSC/CORE

Harlan Krumholz, M.D., S.M.
Harold H. Hines Jr. Professor of Medicine, Yale University School of Medicine

Zhenqiu Lin, PhD.
Senior Analyst, YNHHSC/CORE

Carole Oladele, M.P.H.
Research Assistant, YNHHSC/CORE

Smitha Vellanky, MSc.
Research Assistant, YNHHSC/CORE

Yongfei Wang, M.S.
Analyst, Yale University School of Medicine

The Working Group

The Working Group (WG) is comprised of individuals with expertise relevant to orthopedic quality measurement. The Yale team conducts bimonthly meetings with the WG to obtain detailed feedback and guidance on key clinical and methodological decisions pertaining to measure development (see Appendix A for the call schedule). The group provides a forum for focused expert review and discussion of technical issues during measure development prior to consideration by the broader TEP.

Working Group Members

Daniel J. Berry, MD
Professor of Orthopedics, Mayo Clinic College of Medicine
Chair, Department of Orthopædic Surgery, Mayo Clinic

Kevin J. Bozic, MD, MBA
Associate Professor and vice chair, Department of Orthopaedic Surgery at the University of California, San Francisco
Chair, Health Systems Committee, AAOS

Robert Bucholz, MD
Professor, Orthopædic Surgery, University of Texas Southwestern Medical Center
Past President, American Academy of Orthopædic Surgeons (AAOS)

Lisa Gale Suter, MD
Assistant Professor, Yale University School of Medicine, Rheumatology (West Haven Veterans Association Hospital)

Charles M. Turkelson, PhD
Director of Research and Scientific Affairs, AAOS

Lawrence Weis, MD
Assistant Professor, Yale Orthopædics and Rehabilitation, Yale University School of Medicine, Orthopædics (West Haven Veterans Association Hospital)

Types of issues reviewed by the Working Group

- Identifying procedure(s) for inclusion in the measure(s)
- Deciding whether to combine hip and knee procedure cohorts for measurement
- Defining the outcomes to be measured
- Reviewing the criteria for identifying planned readmissions
- Developing coding strategies for capturing severity of complications
- Defining the follow-up periods for complications
- Reviewing the risk adjustment methodology

The Technical Expert Panel

In alignment with the CMS Measures Management System (MMS), YNHHSC/CORE also released a public call for nominations and convened a technical expert panel (TEP). Potential members were solicited via e-mail per recommendations by the WG and CMS.
The role of the TEP is to provide feedback on key methodological decisions, made in consultation with the WG. The TEP is comprised of individuals with diverse perspectives and backgrounds and includes clinicians, consumers, hospitals, purchasers, and experts in quality improvement. The appointment term for the TEP will be through September 30, 2010.

Specific responsibilities of TEP members include:

- Review background materials provided by YNHHSC/CORE prior to each TEP meeting
- Participate in all TEP meetings
- Provide input to YNHHSC/CORE on key clinical, methodological, and other technical decisions
- Provide feedback to YNHHSC/CORE on key policy or other non-technical issues
- Review TEP summary report prior to public release
- Assist in development of proposed reporting framework

Members of the TEP are listed below.

Technical Expert Panel Members

Mark L. Francis, MD
Professor of Medicine and Biomedical Sciences, Chief, Division of Rheumatology, Department of Internal Medicine, Texas Tech University Health Sciences Center
Texas Tech University, Health Sciences Center

Cynthia Jacelon, PhD, RN, CRRN
Associate Professor, School of Nursing, University of Massachusetts
Association of Rehabilitation Nurses

Norman Johanson, MD
Chairman, Orthopedic Surgery, Drexel University College of Medicine

C. Kent Kwoh, MD
Professor of Medicine, Associate Chief and Director of Clinical Research, Division of Rheumatology and Clinical Immunology University of Pittsburgh

Courtland G. Lewis, MD
American Association of Orthopaedic Surgeons

Jay Lieberman, MD
Professor and Chairman, Department of Orthopedic Surgery, University of Connecticut Health Center; Director, New England Musculoskeletal Institute

Peter Lindenauer, MD, M.Sc.
Hospitalist and Health Services Researcher, Baystate Medical Center; Professor of Medicine, Tufts University

Russell Robbins, MD, MBA
Principal, Mercer's Total Health Management

Barbara Schaffer
THA Patient

Nelson SooHoo, MD, MPH
Professor, University of California at Los Angeles

Steven H. Stern, MD
Vice President, Cardiology & Orthopedics/ Neuroscience, UnitedHealthcare

Richard E. White, Jr., MD
American Association of Hip and Knee Surgeons

Technical Expert Panel Meetings

YNHHSC/CORE conducted two TEP meetings to date (see Appendix B for TEP meeting schedule). In contrast to the WG calls, the TEP calls follow a more structured format consisting of presentation of key issues and our proposed approach, followed by open discussion of these issues by the TEP members.

During the first TEP meeting, the Yale team reviewed the measure development process and presented the proposed measure outcomes and cohorts for inclusion in the measures. The second meeting focused on the approach to model building and the risk adjustment methodology. The following recommendations were presented to the TEP:

1. Develop two measures for a combined cohort of THA and TKA procedures:
    - 30-day all-cause readmission
    - Complications measure to include death, surgical, and medical complications

        Death
        Surgical complications
        - Mechanical complications
        - Periprosthetic joint infection requiring at least one of the following procedure codes:
            - Incision and drainage
            - Revision
            - Removal
        - Wound infection requiring at least one of the following procedure codes:
            - Incision and drainage
            - Revision
            - Removal
        - Surgical site bleeding requiring incision and drainage
        - Pulmonary embolism

        Medical complications
        - Acute myocardial infarction (AMI)
        - Pneumonia
        - Sepsis/septicemia

2. Do not count elective, planned readmissions in the readmission measure

3. Use complication-specific follow-up periods

7 Days	**30 Days**	**90 Days**
Acute myocardial infarction	Death	Mechanical complications
Pneumonia	Surgical site bleeding	Periprosthetic joint infection
Sepsis/septicemia	Wound infection	
	Pulmonary embolism	

The TEP supported these complementary measures with some revisions, as detailed in the tables 1 and 2 below. The TEP agreed, as revised, the measures assess separate domains of quality, with limited overlap. The complications measure will inform targeted quality improvement efforts and the readmission measure captures an additional domain of care including transition to outpatient settings. Tables 1 and 2 detail the key issues discussed during the first two TEP meetings and the TEP's responses.

Table 1. Key Issues Discussed on Death and Complications Measure and TEP Feedback

Key Issues Discussed	TEP Feedback
Definitions of complications included in the measure After conducting a comprehensive literature review and in consultation with the Working Group (WG), YNHHSC/CORE identified complications for inclusion in a death and complications measure. The complications met the following criteria: o Represent significant complications attributable to the THA/TKA procedures o Are identifiable in administrative claims data o Are fair to hospitals and physicians For complications with varying severity (periprosthetic joint infection, wound infection, surgical site bleeding), YNHHSC/CORE, in consultation with the WG, recommended requiring procedures/interventions associated with these complications as indicators of severity. The complications presented to the TEP included: Death Surgical complications o Mechanical complications o Periprosthetic joint infection (requiring incision and drainage and/or removal or revision) o Surgical site bleeding (requiring incision and drainage) o Wound infection (requiring incision and drainage) o Pulmonary embolism Medical complications o Acute myocardial infarction (AMI) o Pneumonia o Sepsis/septicemia	The TEP agreed that the complications captured in the measure ought to be clinically significant and, to the extent possible, attributable to the hip or knee procedure. Using procedures/ interventions as a marker of severity for complications was well received. The TEP suggested modifying the criteria for wound infection so that it is consistent with that for periprosthetic joint infection (PJI) as the codes for PJI and wound infection are frequently used interchangeably. Based on this recommendation, YNHHSC/CORE added removal or revision to the definition of wound infection.

Key Issues Discussed	TEP Feedback
Determination of Follow-up Period for Complications Defining the most appropriate follow-up period for surgical and medical complications was a key step. To inform this decision, YNHHSC/CORE and the WG reviewed the unadjusted complication rates for each complication over a 90-day period. Most complication rates peaked during the index admission period and then reached a plateau approximately 30 days following the date of admission. The team agreed to a 30-day follow-up period for surgical complications and death and a 7-day follow-up period for the medical complications (AMI, pneumonia, and sepsis/septicemia). Follow-up was limited to 7 days for the medical complications because WG members felt they were more likely to be attributable to the procedure if they occurred within 7 days of the index admission date. Furthermore, a 7-day follow-up period would limit overlap with the 30-day all-cause readmission measure.	After reviewing the analyses, the TEP members agreed that a 30-day follow-up period was appropriate for most surgical complications and death. They noted that the follow-up period should reflect complications that are reasonably attributable to the procedure and/or care at during the index hospitalization. Some members noted that mechanical complications and PJI occurring 90 days post procedure can still be attributable to the index procedure as they are directly related to the procedure itself. The TEP suggested extending the follow-up period for mechanical complications and PJI to 90 days post the index admission. YNHHSC/CORE made this change to the measure. The final definitions and timeframes for the complications included in the measure are as follows: 7-day follow-up period (from date of index admission to 7 days post date of index admission) o AMI o Pneumonia o Sepsis/septicemia 30-day follow-up period (from date of index admission to 30 days post date of index admission) o Death o Wound infection o Surgical site bleeding o Pulmonary embolism 90-day follow-up period (from date of index admission to 30 days post date of index admission) o Mechanical complications o Periprosthetic joint infection

Table 2. Key Issues Discussed on Readmission Measure and TEP Feedback

Key Issues Discussed	TEP Feedback
Risk Adjustment Methodology YNHHSC/CORE presented the risk adjustment methodology and reviewed candidate and final variables for inclusion in the risk-standardized readmission model. • Goal is to adjust for patient demographic and clinical characteristics while illuminating important quality differences. This methodology is consistent with guidance from NQF. • The models adjust for case mix differences based on the clinical status of the patient at the time of admission. Conditions that may represent adverse outcomes due to care received during the index admission are not included in the risk adjusted model (Appendix B). Although these adverse outcomes certainly increase the risk of mortality, complications, and readmission, including them as covariates in a risk-adjusted model could attenuate the measure's ability to accurately characterize the quality of care delivered by hospitals. • Consistent with NQF guidelines, the models do not adjust for patients' admission source and their discharge disposition (e.g. skilled nursing facility) because these factors are associated with structure of the health care system, not solely patients' clinical risk factors. • Likewise, the models do not adjust for socioeconomic status (SES), race, or ethnicity because risk-adjusting for these factors would hold hospitals to different standards of care depending on their case mix.	Several TEP members voiced strong concern that SES was not included as a covariate in the risk-standardized models, as it may be inversely associated with adverse outcomes post THA and TKA. Furthermore, the members expressed concern that not adjusting for SES could create perverse incentives for hospitals to avoid treatment of low SES patients otherwise needing elective hip or knee replacements. YNHHSC/CORE explained that this issue has been carefully considered and explained that there may be disparities in the quality of the care provided to low SES populations, and that risk adjusting for these factors would obscure these disparities. YNHHSC/CORE noted that patients of lower SES have more comorbid conditions and that the models adjust for comorbidities in the risk-standardized models. In order to further address the TEP's concerns, YNHHSC/CORE agreed to perform additional analyses to determine the potential impact of SES status on hospitals' risk standardized outcome rates (both for readmission and complications) and if necessary to consider stratifying the measure by SES.

Key Issues Discussed	TEP Feedback
Exclusion of Planned Readmissions from the Measure Some patients undergo a second elective THA/TKA within 30 days of the index hospitalization and are therefore scheduled for a readmission to the hospital. We identify these as planned readmissions and they do NOT count as readmissions in the measure if they occur between 8 and 30 days post date of discharge. **Rationale:** • It is unlikely for a patient to undergo a second elective THA/TKA within one week of the index procedure. If a patient receives a second primary THA/TKA within 7 days of the index procedure, the readmission is more likely to result from a complication from the index procedure. This type of readmission may also be coded erroneously as an elective rather than a revision procedure. • If a patient receives a second primary THA/TKA 8-30 days following the index procedure, and is accompanied with a primary discharge diagnosis of osteoarthritis, the readmission is likely planned and will not be counted as a readmission in the measure. In the coming years, we will conduct a validation study using medical records to confirm the accuracy of this approach.	The TEP agreed that not counting planned readmissions in the measure is critical to the face validity of the measure. TEP members suggested revising the criteria for identifying planned readmissions for another elective THA/TKA to include the following primary discharge diagnosis codes because patients with these diagnoses also undergo elective THA/TKA: • Rheumatoid arthritis • Osteonecrosis • Arthropathy (excluding septic arthropathy codes) Some TEP members also noted that patients may be readmitted for another elective procedure less than 8 days post index discharge date and suggested we identify these patients at any time from the index date of admission. YNHHSC/CORE, in consultation with the WG, modified the criteria to identify and not count as readmissions in the measure planned readmissions at any time from the date of discharge to 30 days post date of discharge.
Preliminary GLM Model Results for 30-day All-cause Readmission Measure YNHHSC/CORE presented the preliminary results of the GLM model to the TEP during the second meeting. The model had an ROC of 0.64 and presented the risk factors associated with readmission.	TEP members reviewed the preliminary model and did not have any question/issues regarding the model or the model performance.

Conclusion

TEP feedback was instrumental in refining our approach to measure development. The Working Group and the Technical Expert Panel continue to provide clinical and methodological expertise and YNHHSC/CORE will consult with both groups as the models are further refined. After our final consultation with the TEP members, we will present the final models to the NQF in September of 2010.

Appendix A: Working Group Conference Call Schedule (to date)

1. February 19, 2010 (Kickoff call)
2. February 26, 2010
3. March 26, 2010
4. April 23, 2010
5. April 27, 2010
6. May 7, 2010
7. May 21, 2010
8. June 4, 2010
9. June 18, 2010
10. July 2, 2010

Appendix B: Technical Expert Panel Call Schedule (to date)

1. June 11, 2010, 12:30-2:00pm ET
2. July 1, 2010, 3:30-5:00pm ET

Appendix C: Detailed Complication Specifications

MECHANICAL COMPLICATIONS

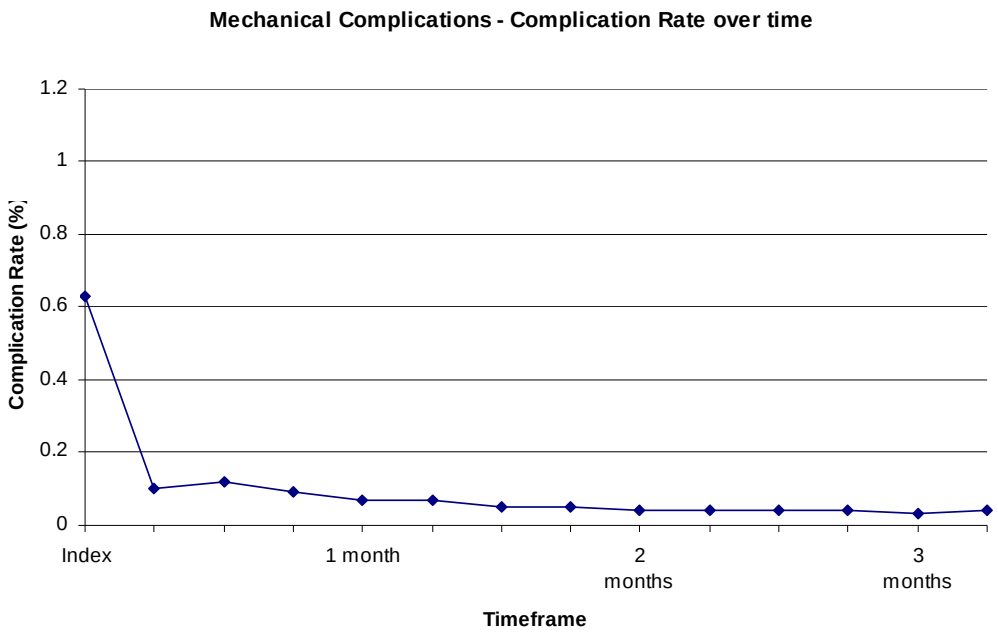
Complication ICD-9 Code*	Description
996.4[1]	Mechanical complication of internal orthopedic device implant and graft
996.40[2]	Unspecified mechanical complication of internal orthopedic device, implant, and graft
996.41[2]	Mechanical loosening of prosthetic joint
996.42[2]	Dislocation of prosthetic joint
996.44[2]	Peri-prosthetic fracture around prosthetic joint
996.47[2]	Other mechanical complication of prosthetic joint implant
996.49[2]	Other mechanical complication of other internal orthopedic device, implant, and graft

When to Count as Complication	
Index Admission	**Rationale**
• Presence of any mechanical complication code listed above in a primary or secondary diagnosis field	• These codes identify mechanical complications related to the index procedure
Readmission	
• Presence of any mechanical complication code listed above in a primary or secondary diagnosis field	• These codes identify all mechanical complications, including those identified at the time of a readmission (even though mechanical complication may not be the primary reason for that readmission), since all are likely to be procedure-related
Follow-up Period for Complications Measure	
• During index admission or within 90 days from admission date	• Data indicate that the rate is elevated until 90 days post procedure • Mechanical complications occurring 90 days post procedure can still be attributable to the index procedure

[1] Weaver F, Hynes D, Hopkinson W, Wixson R, Khuri S, Daley J, Henderson W. (2003). Preoperative risks and outcomes of hip and knee arthroplasty in the Veterans Health Administration. *J Arthroplasty*, 18(6): 693-708.

[2] Memtsoudis S, Gonzalez Ella Valle A, Besculides M, Gaber L, Sculco T. (2008). In-hospital complications and mortality of unilateral, bilateral, and revision TKA. *Clin Orthop Relat Res*, 466:2617-2627.

*NOTE: Mechanical complication codes not used: 996.43, 996.45, 996.46



Data Source: Medicare Part A Inpatient Data, 2008

PERIPROSTHETIC JOINT INFECTION (PJI)

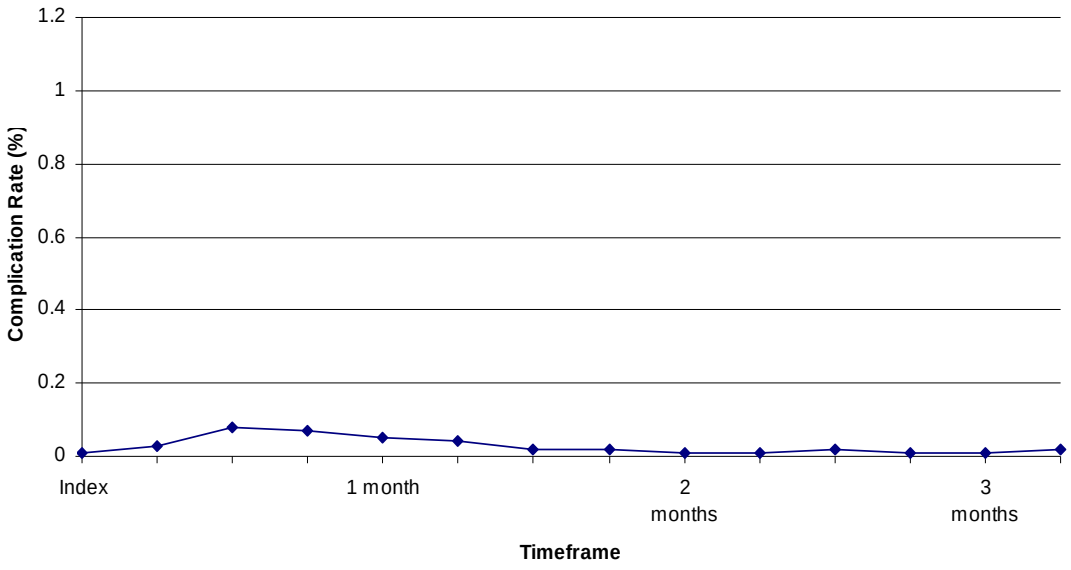
Complication ICD-9 Code	Description
996.66[3]	Infection and inflammatory reaction due to internal joint prosthesis

Intervention ICD-9 Code	Description
86.22	Excisional debridement of wound, infection, or burn
86.28	Nonexcisional debridement of wound, infection, or burn
86.04	Other incision with drainage of skin and subcutaneous tissue
81.53	Revise Hip Replacement, NOS
81.55	Revision of Knee replacement, NOS
81.59	Revision of joint replacement of lower extremity, not elsewhere classified
00.70	REV Hip Repl-acetab/fem
00.71	REV Hip Repl-acetab comp
00.72	REV Hip Repl-fem comp
00.73	REV Hip Repl-liner/head
00.80	Replacement of femoral, tibial, and patellar components (all components)
00.81	Replacement of tibial baseplate and tibial insert (liner)
00.82	Revision of knee replacement, femoral component
00.83	Revision of knee replacement, patellar component
00.84	Revision of total knee replacement, tibial insert (liner)
80.05	Arthrotomy for removal of prosthesis, hip
80.06	Arthrotomy for removal of prosthesis, knee
80.09	Arthrotomy for removal of prosthesis, other unspecified sites

[3] Thomas C, Cadwallader HL, Riley TV. (2004). Surgical-site infections after orthopaedic surgery: statewide surveillance using linked administrative databases. *J Hosp Infect*, (57(1): 25-30.

When to Count as Complication	
Index Admission	**Rationale**
• Presence of periprosthetic joint infection code listed above in a primary or secondary diagnosis field AND the presence of <u>at least one</u> of the following procedure codes: o Incision and drainage o Revision o Removal	• These codes identify periprosthetic joint infection related to the index procedure • Requiring an intervention sets an appropriate threshold for severity and will therefore more likely capture true joint infections and reduce false positives
Readmission	
• Presence of periprosthetic joint infection code listed above in a primary or secondary diagnosis field AND the presence of <u>at least one</u> of the following procedure codes: o Incision and drainage o Revision o Removal	• These codes identify all periprosthetic joint infections, including those identified at the time of a readmission (even though PJI may not be the primary reason for that readmission), since all are likely to be procedure-related
Follow-up Period for Complications Measure	
• During index admission or within 90 days from admission date	• Although the rate tapers off after approximately 6 weeks, it remains slightly elevated until 90 days post procedure • Periprosthetic joint infections occurring 90 days post procedure can still be attributable to the index procedure

Periprosthetic joint infection with Incision & Drainage and/or Revision/Removal - Complication Rate over Time



Data source: Medicare Part A Inpatient Data, 2008

SURGICAL SITE BLEEDING

Complication ICD-9 Code	Description
998.1[4,5,6]	Hemorrhage or hematoma complicating a procedure not elsewhere classified
998.11[1,3,7,8]	Hemorrhage complicating a procedure
998.12[1,3,4,5]	Hematoma complicating a procedure
998.13[3]	Seroma complicating a procedure
286.5[5]	Bleeding from anticoagulation
719.10[1]	Hemarthrosis site unspecified
719.16[1]	Hemarthrosis involving lower leg
719.17[1]	Hemarthrosis involving ankle and foot

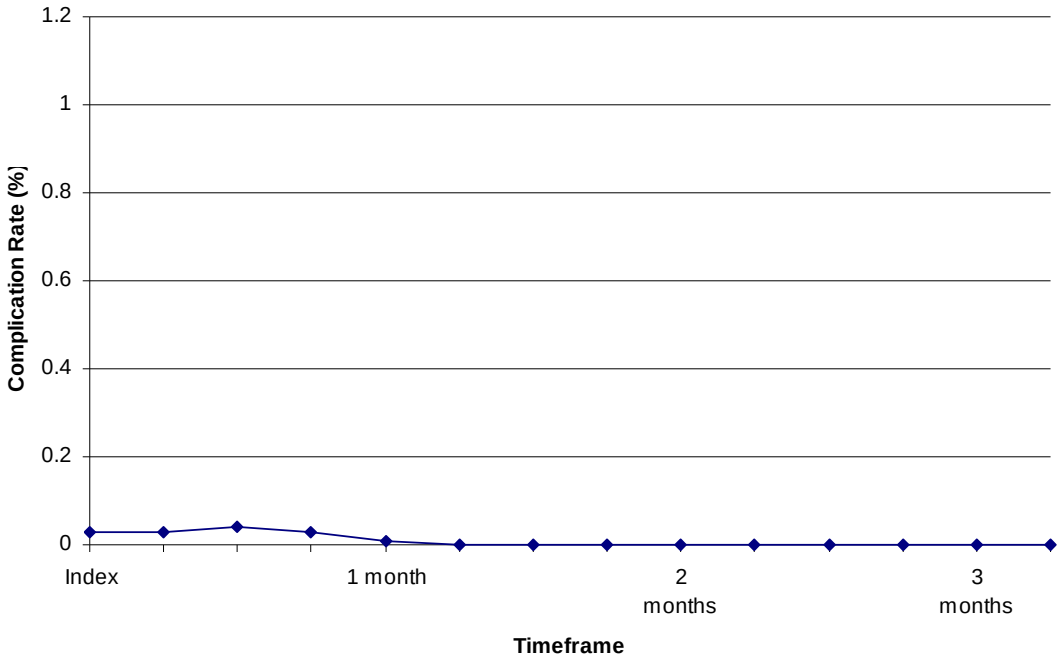
Intervention ICD-9 Code	Description
86.04	Other incision with drainage of skin and subcutaneous tissue
86.22	Excisional debridement of wound, infection, or burn
86.28	Nonexcisional debridement of wound, infection, or burn

When to Count as Complication	Rationale
Index Admission	
• Presence of any bleeding code listed above in a primary or secondary diagnosis field AND: o procedure code for incision and	• These codes identify surgical site bleeding related to the index procedure • Requiring an intervention sets an appropriate

[4] Bozic K, Vail T, Pekow P, Maselli J, Lindenauer P, Auerbach A. (2009). Does aspirin have a role in venous thromboembolism prophylaxis in total knee arthroplasty patients? *J Arthroplasty*, 00(0): 1-8.
[5] Memtsoudis S, Gonzalez Ella Valle A, Besculides M, Gaber L, Sculco T. (2008). In-hospital complications and mortality of unilateral, bilateral, and revision TKA. *Clin Orthop Relat Res*, 466:2617-2627.
[6] Deyo R, Martin B, Kreuter W, Jarvik J, Mirza S. (2010). Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA*, 303(13): 1259-65.
[7] *Version 4.1 technical documentation* AHRQ Quality Indicators. December, 2009. Agency for Healthcare Research and Quality, Rockville, MD. http://www.qualityindicators.ahrq.gov/TechnicalSpecs41.htm
[8] Weaver F, Hynes D, Hopkinson W, Wixson R, Khuri S, Daley J, Henderson W. (2003). Preoperative risks and outcomes of hip and knee arthroplasty in the Veterans Health Administration. *J Arthroplasty*, 18(6): 693-708.

drainage	threshold for severity and will therefore more likely capture true surgical site bleeding and reduce false positives
Readmission	
• Presence of any bleeding code listed above in the primary or secondary diagnosis fields AND: o procedure code for incision and drainage	• These codes identify all surgical site bleeds, including those identified at the time of a readmission (even though bleeding may not be the primary reason for that readmission), since all are likely to be procedure-related
Follow-up Period for Complications Measure	
• During index admission or within 30 days from admission date	• Data indicate that rate decreases after 30 days • Consistent with clinical course

Surgical site bleeding with Incision & Drainage - Complication Rate over Time



Data Source: Medicare Inpatient Part A Data, 2008

WOUND INFECTION

Complication ICD-9 Code*	Description
998.6[2,9]	Persistent postoperative fistula not elsewhere classified
998.83[2,3,10]	Non-healing surgical wound
998.3[4]	Disruption of wound
998.30[2,3,4]	Disruption of wound, unspecified
998.31[2,3,4]	Disruption of internal operation (surgical) wound
998.32[2,3,4]	Disruption of external operation (surgical) wound
998.33	Disruption of traumatic wound repair
998.5[2,3,4,11]	Postoperative infection not elsewhere classified
998.51[4]	Infected postoperative seroma
998.59[4,12]	Other postoperative infection
996.67[7]	Infection and inflammatory reaction due to other internal orthopedic device implant and graft

Intervention ICD-9 Code	Description
86.22	Excisional debridement of wound, infection, or burn
86.28	Nonexcisional debridement of wound, infection, or burn
86.04	Other incision with drainage of skin and subcutaneous tissue
81.53	Revise Hip Replacement, NOS
81.55	Revision of Knee replacement, NOS
81.59	Revision of joint replacement of lower extremity, not elsewhere classified
00.70	REV Hip Repl-acetab/fem
00.71	REV Hip Repl-acetab comp
00.72	REV Hip Repl-fem comp
00.73	REV Hip Repl-liner/head
00.80	Replacement of femoral, tibial, and patellar components (all components)
00.81	Replacement of tibial baseplate and tibial insert (liner)
00.82	Revision of knee replacement, femoral component
00.83	Revision of knee replacement, patellar component
00.84	Revision of total knee replacement, tibial insert (liner)
80.05	Arthrotomy for removal of prosthesis, hip
80.06	Arthrotomy for removal of prosthesis, knee
80.09	Arthrotomy for removal of prosthesis, other unspecified sites

[9] Memtsoudis S, Gonzalez Ella Valle A, Besculides M, Gaber L, Sculco T. (2008). In-hospital complications and mortality of unilateral, bilateral, and revision TKA. *Clin Orthop Relat Res*, 466:2617-2627.

[10] Deyo R, Martin B, Kreuter W, Jarvik J, Mirza S. (2010). Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA*, 303(13): 1259-65.

[11] Thomas C, Cadwallader HL, Riley TV. (2004). Surgical-site infections after orthopaedic surgery: statewide surveillance using linked administrative databases. *J Hosp Infect*, (57(1): 25-30.

[12] Centers for Medicare and Medicaid Services No-Pay List

*__NOTE: Wound infection codes not used: 890.0, 890.1, 890.2, 891.0, 891.1, 891.2, 894.1, 894.2, 998.89, 999.3, 999.31, 999.39, 686.9, 682.5, 682.6__

When to Count as Complication	
Index Admission	**Rationale**
• Presence of any wound infection code listed above in a primary or secondary diagnosis field AND the presence of <u>at least one</u> of the following procedure codes: o Incision and drainage o Revision o Removal	• These codes identify wound infection related to the index procedure • Requiring an intervention sets an appropriate threshold for severity and will therefore capture true wound infections and reduce false positives
Readmission	
• Presence of any wound infection code listed above in a primary or secondary diagnosis field AND the presence of <u>at least one</u> of the following procedure codes: o Incision and drainage o Revision o Removal	• These codes identify all wound infections, including those identified at the time of a readmission (even though wound infection may not be the primary reason for that readmission), since all are likely to be procedure-related
Follow-up Period for Complications Measure	
• During index admission or within 30 days from admission date	• Data indicate that rate decreases after 30 days • Consistent with clinical course

Data Source: Medicare Inpatient Data, 2008

PULMONARY EMBOLISM (PE)

Complication	ICD-9 Code	Description
	415.1[13,14,15,16,17,18]	Pulmonary embolism and infarction
	415.11[1,2,3,6]	Iatrogenic pulmonary embolism and infarction
	415.19[1,2,3,6]	Other pulmonary embolism and infarction

When to Count as Complication	
Index Admission	**Rationale**
• Presence of any pulmonary embolism code listed in the primary or secondary diagnosis fields	• These codes identify PE related to the index procedure
Readmission	
• Presence of any pulmonary embolism code listed above in the primary or secondary diagnosis fields	• These codes identify all PEs, including those identified at the time of a readmission (even though PE may not be the primary reason for that readmission), since all are likely to be procedure-related
Follow-up Period for Complications Measure	
• During index admission or within 30 days from admission date	• Data indicate that rate decreases after 30 days • Consistent with clinical course

[13] *Version 4.1 technical documentation* AHRQ Quality Indicators. December, 2009. Agency for Healthcare Research and Quality, Rockville, MD. http://www.qualityindicators.ahrq.gov/TechnicalSpecs41.htm

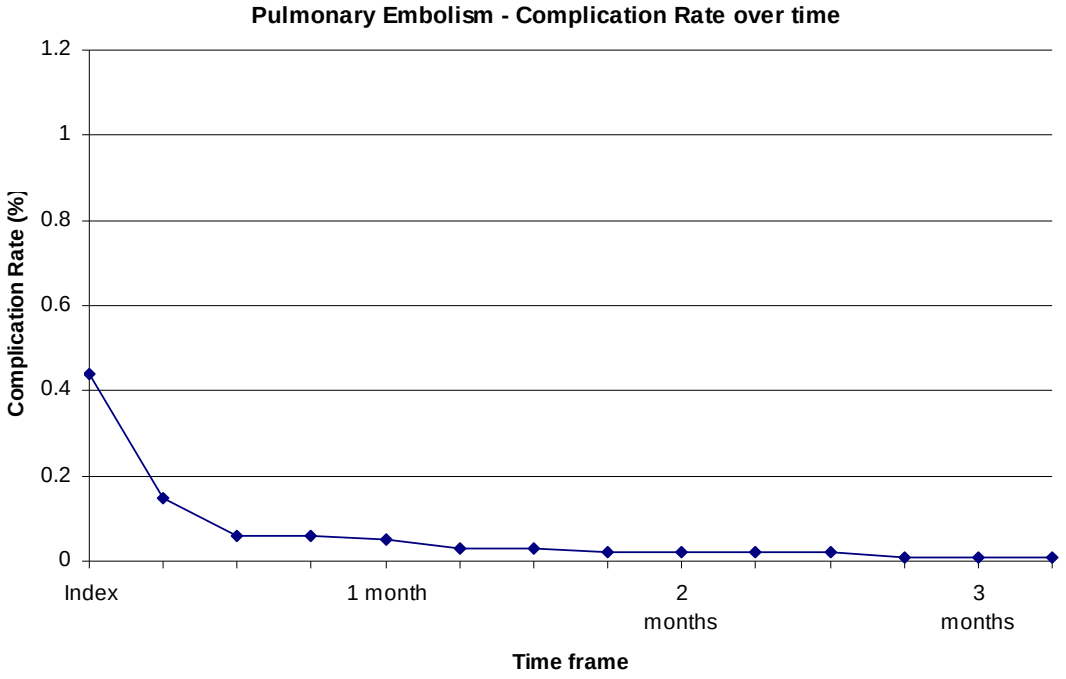
[14] Solomon D, Chibnik L, Losina E, Huang J, Fossel A, Husni E, Katz J. (2006). Development of a preliminary index that predicts adverse events after total knee replacement. *Arthritis Rheum*, 54(5): 1536-1542.

[15] Huddleston J, Maloney W, Wang Y, Verzier N, Hunt D, Herndon J. (2009). Adverse events after total knee arthroplasty. J Arthroplasty, 24(6): 95-100.

[16] Memtsoudis S, Gonzalez Ella Valle A, Besculides M, Gaber L, Sculco T. (2008). In-hospital complications and mortality of unilateral, bilateral, and revision TKA. *Clin Orthop Relat Res*, 466:2617-2627.

[17] Weaver F, Hynes D, Hopkinson W, Wixson R, Khuri S, Daley J, Henderson W. (2003). Preoperative risks and outcomes of hip and knee arthroplasty in the Veterans Health Administration. *J Arthroplasty*, 18(6): 693-708.

[18] Deyo R, Martin B, Kreuter W, Jarvik J, Mirza S. (2010). Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA*, 303(13): 1259-65.



Data Source: Medicare Inpatient Part A Data, 2008

ACUTE MYOCARDIAL INFARCTION (AMI)

Complication ICD-9 Code	Description
*410[19,20]	Acute myocardial infarction
410.0[1,21]	Acute myocardial infarction of anterolateral wall
410.00[1]	Acute myocardial infarction of anterolateral wall episode of care unspecified
410.01[1]	Acute myocardial infarction of anterolateral wall initial episode of care
410.1[1,3]	Acute myocardial infarction of other anterior wall
410.10[1]	Acute myocardial infarction of other anterior wall episode of care unspecified
410.11[1]	Acute myocardial infarction of other anterior wall initial episode of care
410.2[1,3]	Acute myocardial infarction of inferolateral wall
410.20[1]	Acute myocardial infarction of inferolateral wall episode of care unspecified
410.21[1]	Acute myocardial infarction of inferolateral wall initial episode of care
410.3[1,3]	Acute myocardial infarction of inferoposterior wall
410.30[1]	Acute myocardial infarction of inferoposterior wall episode of care unspecified
410.31[1]	Acute myocardial infarction of inferoposterior wall initial episode of care
410.4[1,3]	Acute myocardial infarction of other inferior wall
410.40[1]	Acute myocardial infarction of other inferior wall episode of care unspecified
410.41[1]	Acute myocardial infarction of other inferior wall initial episode of care
410.5[1,3]	Acute myocardial infarction of other lateral wall
410.50[1]	Acute myocardial infarction of other lateral wall episode of care unspecified
410.51[1]	Acute myocardial infarction of other lateral wall initial episode of care
410.6[1,3]	True posterior wall infarction
410.60[1]	True posterior wall infarction episode of care unspecified
410.61[1]	True posterior wall infarction initial episode of care
410.7[1,3]	Subendocardial infarction
410.70[1]	Subendocardial infarction episode of care unspecified
410.71[1]	Subendocardial infarction initial episode of care
410.8[1,3]	Acute myocardial infarction of other specified sites
410.80[1]	Acute myocardial infarction of other specified sites episode of care unspecified
410.81[1]	Acute myocardial infarction of other specified sites initial episode of care
410.9[1,3]	Acute myocardial infarction of unspecified site
410.90[1]	Acute myocardial infarction of unspecified site episode of care unspecified
410.91[1]	Acute myocardial infarction of unspecified site initial episode of care

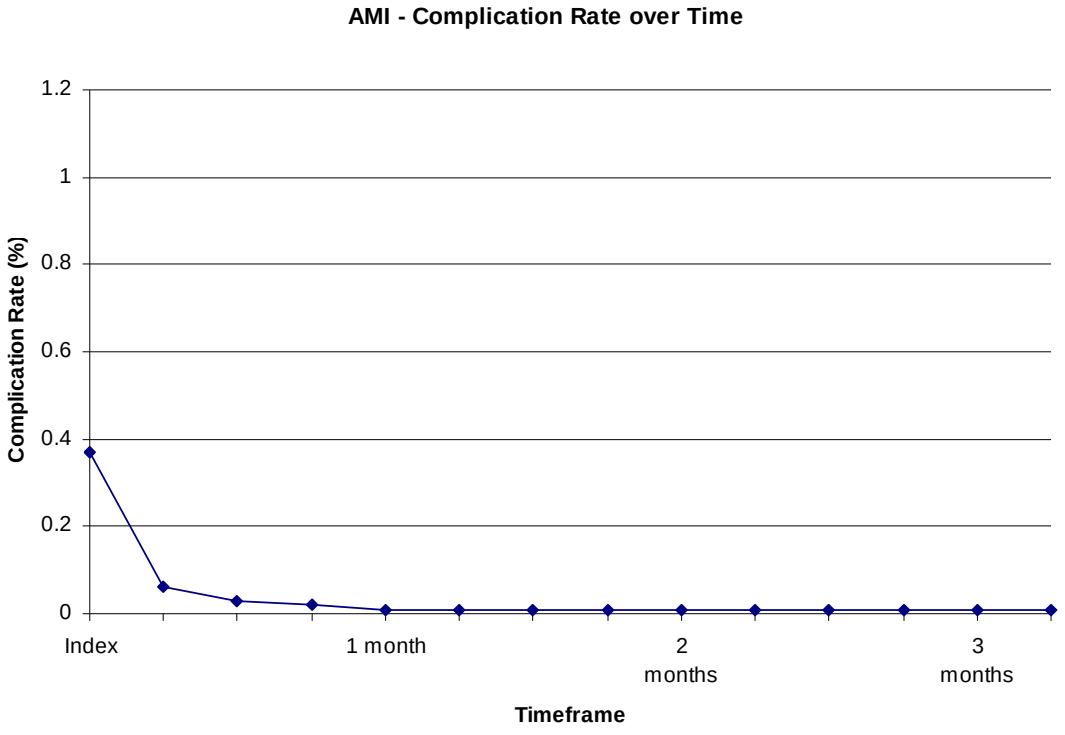
[19] Yale/CORE cohort definition for pneumonia

[20] Weaver F, Hynes D, Hopkinson W, Wixson R, Khuri S, Daley J, Henderson W. (2003). Preoperative risks and outcomes of hip and knee arthroplasty in the Veterans Health Administration. *J Arthroplasty*, 18(6): 693-708.

[21] Deyo R, Martin B, Kreuter W, Jarvik J, Mirza S. (2010). Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA*, 303(13): 1259-65.

* **NOTE: Excludes the following code: 0**410.x2

When to Count as Complication	
Index Admission	**Rationale**
• Presence of any AMI code listed above in a primary or secondary diagnosis field	• These codes identify AMI related to the index procedure
Readmission	
• Presence of any AMI code listed above in a primary field only	• These codes identify AMI's that were the primary reason for a readmission • AMIs that are secondary diagnoses in readmissions may represent a history of AMI or a complication of the second admission
Follow-up Period for Complications Measure	
• During index admission or within 7 days from index admission date	• More likely to be attributable to procedure if it occurs within 7 days of procedure • Rate decreases sharply 7 days from admission and returns to baseline within 30 days • Limits overlap with 30-day all-cause readmission measure



Data source: Medicare Part A Inpatient Data, 2008

PNEUMONIA

Complication ICD-9 Code	Description
480[22]	Viral pneumonia
480.0[1]	Pneumonia due to adenovirus
480.1[1]	Pneumonia due to respiratory syncytial virus
480.2[1]	Pneumonia due to parainfluenza virus
480.3[1]	Pneumonia due to sars-associated coronavirus
480.8[1]	Pneumonia due to other virus not elsewhere classified
480.9[1]	Viral pneumonia unspecified
481[1,23,24,25,26]	Pneumococcal pneumonia
482[4,5]	Other Bacterial Pneumonia
482.0[1,5]	Pneumonia due to klebsiella pneumoniae
482.1[1,5]	Pneumonia due to pseudomonas
482.2[1,2,3,5]	Pneumonia due to hemophilus influenzae (h. influenzae)
482.3	Pneumonia due to streptococcus
482.30[1,2,3,5]	Pneumonia due to streptococcus unspecified
482.31[1,2,3,5]	Pneumonia due to streptococcus group a
482.32[1,2,3,5]	Pneumonia due to streptococcus group b
482.39[1,2,3,5]	Pneumonia due to other streptococcus
482.4	Pneumonia due to staphylococcus
482.40[1,5]	Pneumonia due to staphylococcus unspecified
482.41[1,2,3,5]	Methicillin susceptible pneumonia due to staphylococcus aureus
482.42[5]	Methicillin resistant pneumonia due to staphylococcus aureus
482.49[1,5]	Other staphylococcus pneumonia
482.81[1,5]	Pneumonia due to anaerobes
482.82[1,5]	Pneumonia due to escherichia coli [e.coli]
482.83[1,5]	Pneumonia due to other gram-negative bacteria
482.84[1,5]	Pneumonia due to legionnaires' disease
482.89[1,5]	Pneumonia due to other specified bacteria
482.9[1,2,3,5]	Bacterial pneumonia unspecified
483[1,2,3]	Pneumonia due to other specified organism
483.0[1]	Pneumonia due to mycoplasma pneumoniae
483.1[1]	Pneumonia due to chlamydia
483.8[1]	Pneumonia due to other specified organism

[22] Yale/CORE cohort definition for pneumonia

[23] *Version 4.1 technical documentation* AHRQ Quality Indicators. December, 2009. Agency for Healthcare Research and Quality, Rockville, MD. http://www.qualityindicators.ahrq.gov/TechnicalSpecs41.htm

[24] National Quality Forum Endorsed Standard-Bacterial Pneumonia.

[25] Weaver F, Hynes D, Hopkinson W, Wixson R, Khuri S, Daley J, Henderson W. (2003). Preoperative risks and outcomes of hip and knee arthroplasty in the Veterans Health Administration. *J Arthroplasty*, 18(6): 693-708.

[26] Deyo R, Martin B, Kreuter W, Jarvik J, Mirza S. (2010). Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA*, 303(13): 1259-65.

485[1-5] Bronchopneumonia organism unspecified

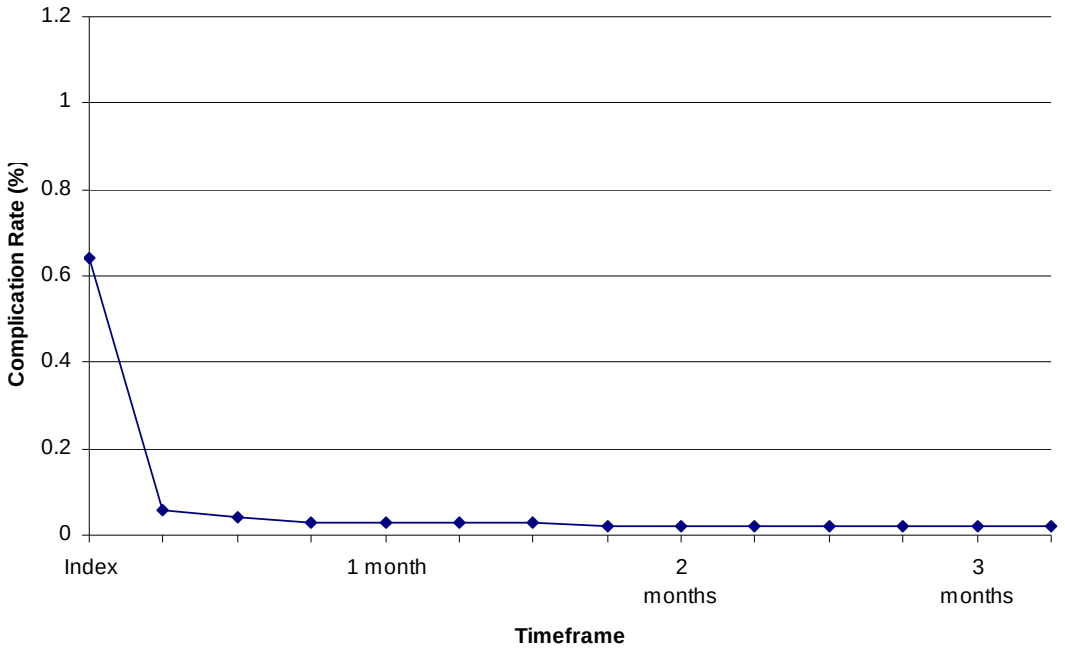
486[1-5] Pneumonia organism unspecified

When to Count as Complication	
Index Admission	**Rationale**
• Presence of any pneumonia code listed above in a primary or secondary diagnosis field	• These codes identify pneumonia related to the index procedure
Readmission	
• Presence of any pneumonia code listed above in a primary diagnosis field only	• These codes identify pneumonias that were the primary reason for a readmission • Pneumonias that are secondary diagnoses in readmissions may represent a history of pneumonia or a complication of the second admission
Follow-up Period for Complications Measure	
• During index admission or within 7 days from index admission date	• More likely to be attributable to procedure if it occurs within 7 days of procedure • Rate decreases sharply 7 days from admission and returns to baseline within 30 days • Limits overlap with 30-day all-cause readmission measure

487.0[1] Influenza with pneumonia

507.0[4] Pneumonitis due to inhalation of food or vomitus

Pneumonia - Complication Rate over Time



Data source: Medicare Part A Inpatient Data, 2008

SEPSIS/SEPTICEMIA

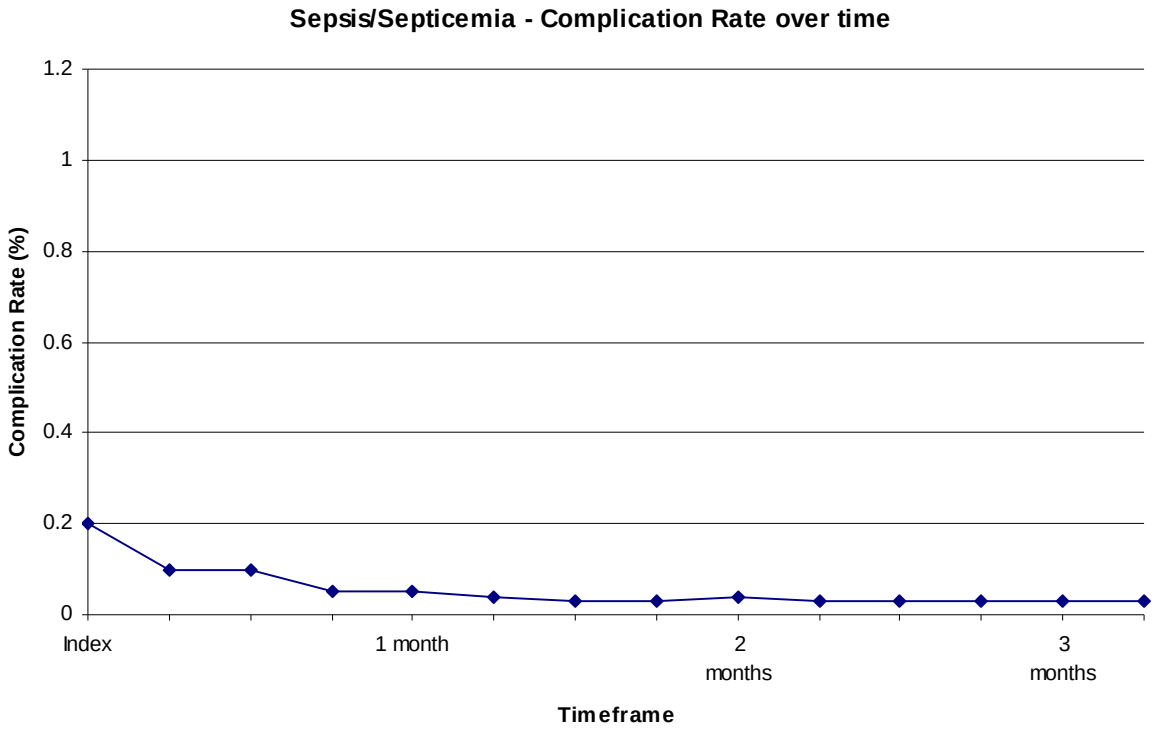
Complications ICD-9 Code	Description
038[27]	Septicemia
038.0[28,29]	Streptococcal septicemia
038.1[2,3]	Staphylococcal septicemia
038.10[2,3]	Staphylococcal septicemia unspecified
038.11[2,3]	Methicillin susceptible staphylococcus aureus septicemia
038.12[2,3]	Methicillin resistant staphylococcus aureus septicemia
038.19[2,3]	Other staphylococcal septicemia
038.2[2,3]	Pneumococcal septicemia
038.3[2,3]	Septicemia due to anerobes
038.4[2,3]	Septicemia due to other gram-negative organisms
038.40[2,3]	Septicemia due to gram negative organisms unspecified
038.41[2,3]	Septicemia due to h. influenzae
038.42[2,3]	Septicemia due to e. coli
038.43[2,3]	Septicemia due to pseudomonas
038.44[2,3]	Septicemia due to serratia
038.49[2,3]	Other septicemia due to gram-negative organisms
038.8[2,3]	Other specified septicemias
038.9[2,3]	Unspecified septicemia
785.52[2,3]	Septic shock
785.59[2,3]	Other shock without trauma
790.7	Bacteremia
995.91[2,3]	Systemic inflammatory response syndrome due to infectious process w/out organ dysfunction
995.92[2,3]	Systemic inflammatory response syndrome due to infectious process with organ dysfunction
998.0[2,3]	Postoperative shock not elsewhere classified
998.59	Post procedural sepsis

[27] Weaver F, Hynes D, Hopkinson W, Wixson R, Khuri S, Daley J, Henderson W. (2003). Preoperative risks and outcomes of hip and knee arthroplasty in the Veterans Health Administration. *J Arthroplasty*, 18(6): 693-708.

[28] *Version 4.1 technical documentation* AHRQ Quality Indicators. December, 2009. Agency for Healthcare Research and Quality, Rockville, MD. http://www.qualityindicators.ahrq.gov/TechnicalSpecs41.htm

[29] Solomon D, Chibnik L, Losina E, Huang J, Fossel A, Husni E, Katz J. (2006). Development of a preliminary index that predicts adverse events after total knee replacement. *Arthritis Rheum*, 54(5): 1536-1542.

When to Count as Complication	
Index Admission	**Rationale**
• Presence of any sepsis/septicemia code listed above in a primary or secondary diagnosis field	• These codes identify sepsis/septicemia related to the index procedure
Readmission	
• Presence of any sepsis/septicemia code listed above in a primary diagnosis or secondary diagnosis field	• Sepsis/septicemia rates will be underestimated if identified using primary diagnosis field only, as these codes are found more frequently in the secondary diagnosis fields • Primary field may indicate the source of sepsis/septicemia
Follow-up Period for Complications Measure	
• During index admission or within 7 days from index admission date	• More likely to be attributable to procedure if it occurs within 7 days of procedure • Rate decreases 7 days from admission and returns to baseline within 30 days • Limits overlap with 30-day all-cause readmission measure



Data source: Medicare Part A Inpatient Data, 2008