



TECHNICAL NOTES *ADDENDUM*

For Complications Following Knee and Hip Replacement

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Pennsylvania Health Care Cost Containment Council

Report Period: Calendar Year 2014

January 1, 2014 through December 31, 2014 Discharges

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OVERVIEW

This *Addendum* to the *Technical Notes for Knee and Hip Replacements*¹ released with calendar year 2013 knee and hip replacements report serves as a technical supplement to the Pennsylvania Health Care Cost Containment Council (PHC4) analysis on complications following knee and hip replacement surgery for discharges from January 1, 2014 through December 31, 2014. This document describes the methodology and development of the complication analysis and includes information on statewide results, cases excluded from the analysis, and risk-adjustment models.

- The analysis included adult patients age 18 or older who underwent a total knee or hip replacement procedure in a Pennsylvania general acute care (GAC) hospital. Results are reported separately for knee and hip replacements.
- The following measures are reported:
 - Total number of knee and hip replacement cases for hospitals, including elective and non-elective² cases.
 - Risk-adjusted complication ratings based, in large part, on the Centers for Medicare and Medicaid Services measure designed for total knee and hip replacements likely to be considered elective.³ This measure is reported for hospitals with five or more cases in the analysis.

The rigorous methodology described in this document was developed to account for the differences among individual patients that had the potential to influence the outcome of knee or hip replacement.

Statewide utilization and outcome data are displayed in Data Table 1.

¹ *Technical Notes for Knee and Hip Replacements* Calendar Year 2013 available on the PHC4 website at <http://www.phc4.org/reports/kneehip/13/>.

² Non-elective cases are clinically complex as defined by the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes in Appendix A, Table A1 and cases *not* in the study's Medicare Severity-Adjusted Diagnosis-Related Groups (MS-DRG) (see Appendix A, Table A2 for MS-DRGs *not* excluded from the study). The clinically complex cases were excluded from the complication analyses.

³ Centers for Medicare and Medicaid Services. "2015 Procedure Specific Complication Measure Updates and Specifications Report: Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) – Version 4.0." March 2014. Available at <http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html>.

DATA COLLECTION AND VERIFICATION

The data for the report on knee and hip replacements, obtained from the inpatient UB-04 (Uniform Billing) form, was submitted electronically to PHC4 by Pennsylvania GAC hospitals that performed knee and hip replacements primarily on adults. Federal hospitals were not included. The data included demographic information, hospital charges, and International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes.

Additionally, laboratory test results were submitted by hospitals to the Council for a select group of acute care inpatient records, including those used in the knee and hip analysis. Hospitals were required to submit the highest and/or lowest result(s) for a maximum of 29 laboratory tests as collected from patients during the initial period of their hospitalization. The requirements for submitting this data are specified elsewhere (refer to PHC4's *Laboratory Data Reporting Manual*, accessible at www.phc4.org). In brief, for patients admitted prior to 6:00 p.m., only laboratory results collected on Day 1 of the admission were to be submitted. For patients admitted after 6:00 p.m., results were to be submitted for tests collected on the day of admission (Day 1) through the next calendar day (Day 2).

Facilities submitted data to the Council on a quarterly basis (within 90 days from the last day of each quarter). Upon receipt of the data, verification was performed to assure data was submitted in a readable format. Extensive quality assurance checks were completed and laboratory data submissions were matched to inpatient records. Error reports for UB-04 data was then generated and returned to each facility with an opportunity to correct any problems. Similarly, laboratory test results were evaluated each quarter and summary reports indicating data anomalies were sent to each facility, again with an opportunity to make corrections.

Death certificate data was obtained to identify deaths that occurred subsequent to the hospitalization in which the knee or hip replacement surgery was performed. These data were supplied by the Bureau of Health Statistics and Research, Pennsylvania Department of Health. The Pennsylvania Department of Health specifically disclaims responsibility for any analyses, interpretations, or conclusions.

STUDY POPULATION

Inclusion Criteria

The study population included records for adult (18 years of age and older) inpatients discharged from Pennsylvania GAC hospitals between January 1, 2014 and December 31, 2014 who underwent total knee and hip replacements, as identified by the presence of one of the following ICD-9-CM procedure codes in either the principal or secondary procedure code positions of the discharge record.

- 81.54 Total Knee Replacement
- 81.51 Total Hip Replacement

Analyses were performed separately for knee and hip replacements.

Exclusion Criteria

Cases meeting certain criteria were excluded from the complication analyses, including:

- Clinically complex cases as defined by the ICD-9-CM codes in Appendix A, Table A1. Table A2 outlines the MS-DRGs that are *not* excluded from the study population.
- Cases with invalid or missing discharge status.
- Patients who left against medical advice.
- Cases with invalid data (i.e., social security number, date of birth, or sex) that could not be linked to subsequent hospitalizations.
- Out-of-state residents, because these patients could undergo a knee or hip replacement in a Pennsylvania hospital, return to their state of residence, and be readmitted to a hospital in their home state. As such, readmission data would not be available for these patients.
- Additional hospitalizations within the study period that meet the study population definition.

Data Table 2 displays exclusion data.

MEASURES REPORTED

Number of Cases

The number of total knee or hip replacement surgery cases reported for hospitals includes elective and non-elective¹ procedures. Not included in this measure are procedures performed on patients less than 18 years old and those performed in Veterans' hospitals, so the actual number of cases for a particular hospital might be higher.

If two joint replacements were performed during the same hospitalization, the case was only counted once. If a knee and a hip replacement were performed during the same hospitalization, the case was assigned to either the knee or hip study population based on the particular diagnosis and procedure codes present in the patient record.

Risk-Adjusted Complication Rating

The complication measure is based, in large part, on the Centers for Medicare and Medicaid Services measure designed for total knee and hip replacements likely to be considered elective.² It is a dichotomous (yes/no) outcome. A complication was counted when at least one of eight complications occurred within a specified time period identified during the admission in which the replacement was performed (referred to as the index hospitalization) or a readmission (see Appendix B for further detail).

- Acute myocardial infarction (AMI), pneumonia, or sepsis/septicemia/shock either 1) during the index hospitalization and not present on admission,³ or 2) the principal diagnosis of a readmission within 7 days of the index hospitalization admission date.
- Surgical site bleeding or pulmonary embolism either 1) during the index hospitalization and not present on admission, or 2) the principal diagnosis of a readmission within 30 days of the index hospitalization admission date.
- Death either 1) during the index hospitalization, or 2) after discharge from the index hospitalization but within 30 days of the index hospitalization admission date.
- Mechanical complications or periprosthetic joint infection/wound infection 1) during index hospitalization and not present on admission, or 2) the principal diagnosis of a readmission within 90 days of the index hospitalization admission date.

This measure is reported for hospitals with five or more cases in the analysis.

¹ Non-elective cases are clinically complex as defined by the ICD-9-CM codes in Appendix A, Table A1. Table A2 outlines the MS-DRGs that are not excluded from the study population.

² Centers for Medicare and Medicaid Services. "2015 Procedure Specific Complication Measure Updates and Specifications Report: Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) – Version 4.0." March 2014. Available at <http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/Measure-Methodology.html>.

³ ICD-9-CM diagnosis codes not present on admission were identified as having a POA indicator of N (No) or U (No information in the record).

RISK-ADJUSTMENT METHODOLOGY AND CALCULATION OF HOSPITAL-SPECIFIC OUTCOMES

In order to report fair comparisons among hospitals, regression techniques were used to construct “risk models” for predicting the risk of complications. Each model was a mathematical formula used to ultimately predict a patient’s probability of complications based on relevant risk factors. Cases with these risk factors were given more “credit” in the calculation, leading to a higher predicted probability of complications. A hospital’s predicted rate was the average predicted probability across all its knee or hip replacement discharges in the analysis. The ratings indicate whether the hospital’s complication rate was within the expected range or higher or lower than the expected range, taking into account the risk factors that were included in the risk-adjustment models.

For details of model development, measures of model adequacy, coefficients and odds ratios, and calculating hospital-specific complication ratings see the *Technical Notes for Knee and Hip Replacements*¹ released with calendar year 2013 knee and hip replacements report.

See Data Tables 3 and 4 of this Addendum for the knee and hip complication models.

See Appendix C for definitions of the potential risk factors defined by ICD-9-CM codes.

¹ *Technical Notes for Knee and Hip Replacements* Calendar Year 2013 available on the PHC4 website at <http://www.phc4.org/reports/kneehip/13/>.

DATA TABLES

TABLE 1. STATEWIDE UTILIZATION AND OUTCOME DATA

CY 2014 Data			
Total Number of Cases			
	#		
Knee	36,307		
Hip	19,866		
Complications			
	Cases*	Complications	
	#	#	%
Knee	32,179	724	2.2%
Hip	16,203	455	2.8%

* The number of cases in the analysis.

TABLE 2. EXCLUSION DATA

Complication Exclusions – Knee and Hip Replacements (CY 2014 Data)

	Knee		Hip	
	#	%	#	%
Total cases before exclusions	36,307	100.0%	19,866	100.0%
<i>Clinically complex cases excluded¹</i>	461	1.3%	1,319	6.6%
Elective cases (total minus clinically complex)	35,846	98.7%	18,547	93.4%
<i>Other exclusions</i>				
• <i>Cases with invalid or missing discharge status</i>	1	<0.1%	2	<0.1%
• <i>Patients who left against medical advice</i>	4	<0.1%	1	<0.1%
• <i>Cases with invalid data²</i>	340	0.9%	176	0.9%
• <i>Out-of-state residents³</i>	1,970	5.4%	1,483	7.5%
• <i>Additional index hospitalizations within the study period</i>	1,352	3.7%	682	3.4%
<i>Total exclusions</i>	4,128	11.4%	3,663	18.4%
Total cases remaining in analysis	32,179	88.6%	16,203	81.6%

¹ Clinically complex as defined by the ICD-9-CM codes in Appendix A, Table A1. Table A2 outlines the MS-DRGs that are not excluded from the study population.

² Cases with invalid data (i.e., social security number, date of birth, or sex) could not be linked to subsequent hospitalizations.

³ Out-of-state residents were excluded because such patients could undergo a knee or hip replacement in a Pennsylvania hospital, return to their state of residence, and be readmitted to a hospital in their home state. Therefore, readmission data would not be available for these patients.

DATA TABLES

TABLE 3. COMPLICATION MODEL FOR KNEE

The c-statistic for the model is 0.63752.

Predictor	Coefficient	Odds Ratio*	p-value
Intercept	-4.0855		
Age (continuous)	-0.0030	0.970	0.6358
Age Over 70 (continuous)	0.0424	1.236	0.0015
Race/Ethnicity (Black non-Hispanic)	0.2535	1.289	0.0784
WBC $\geq 11.0 \times 10^9/L$	0.4579	1.581	0.0056
Atrial Fibrillation and Flutter	0.3777	1.459	0.0034
Chronic Lung Disease	0.4067	1.502	0.0010
Chronic Pulmonary Heart Disease	0.8095	2.247	0.0026
Diabetes	0.2787	1.321	0.0014
Heart Failure	0.7765	2.174	<.0001
Mental Disorders	0.4326	1.541	<.0001
Morbid Obesity	0.3114	1.365	0.0027

* Odds ratio for "Age" is calculated at units of 10 and odds ratios for "Age Over 70" is calculated at units of 5. Using "Age Over 70" as an example, the risk of complications about 24% higher for patients age 75 than for patients age 70.

TABLE 4. COMPLICATION MODEL FOR HIP

The c-statistic for the model is 0.65819.

Predictor	Coefficient	Odds Ratio*	p-value
Intercept	-4.3301		
Age (continuous)	0.0017	1.017	0.7404
Age Over 80 (continuous)	0.0832	1.516	0.0040
Female	0.2457	1.279	0.0146
Glucose 0 to <136 mg/dL	0.4213	1.524	0.0016
WBC $\geq 11.0 \times 10^9/L$	0.7605	2.139	<.0001
Aseptic Necrosis of Knee/Hip Joint	0.6001	1.822	0.0003
Diabetes	0.8144	2.258	0.0029
Heart Failure	0.7596	2.138	0.0007
History of Knee and Hip Joint Replacement	0.3305	1.392	0.0055
Mental Disorders	0.5042	1.656	<.0001
Morbid Obesity	0.6782	1.970	<.0001

* Odds ratio for "Age" is calculated at units of 10 and odds ratio for "Age Over 80" is calculated at units of 5. Using "Age Over 80" as an example, the risk of complications is about 51% higher for patients age 85 than for patients age 80.

APPENDICES

APPENDIX A: EXCLUSION DEFINITIONS

TABLE A1. CLINICAL COMPLEXITY EXCLUSIONS

ICD-9-CM Code	Description
Diagnosis (principal diagnosis only)	
170.6	Malignant neoplasm of pelvic bones, sacrum, and coccyx
170.7	Malignant neoplasm of long bones of lower limb
170.9	Malignant neoplasm of bone and articular cartilage, site unspecified
195.3	Malignant neoplasm of pelvis
195.5	Malignant neoplasm of lower limb
198.5	Secondary malignant neoplasm of bone and bone marrow
199.0	Disseminated malignant neoplasm
996.40	Unspecified mechanical complication of internal orthopedic device, implant, and graft
996.41	Mechanical loosening of prosthetic joint
996.42	Dislocation of prosthetic joint
996.43	Broken prosthetic joint implant
996.44	Peri-prosthetic fracture around prosthetic joint
996.45	Peri-prosthetic osteolysis
996.46	Articular bearing surface wear of prosthetic joint
996.47	Other mechanical complication of prosthetic joint implant
996.49	Other mechanical complication of other internal orthopedic device, implant, and graft
996.66	Infection and inflammatory reaction due to internal joint prosthesis
996.67	Infection and inflammatory reaction due to other internal orthopedic device, implant, and graft
996.77	Other complications due to internal joint prosthesis
996.78	Other complications due to other internal orthopedic device, implant, and graft
Diagnosis (any position)	
733.10	Pathological fracture, unspecified site
733.14	Pathological fracture of neck of femur
733.15	Pathological fracture of other specified part of femur
733.19	Pathological fracture of other specified site
733.81	Malunion of fracture
733.82	Nonunion of fracture
733.95	Stress fracture of other bone
733.96	Stress fracture of femoral neck
733.97	Stress fracture of shaft of femur
808.0	Closed fracture of acetabulum
808.1	Open fracture of acetabulum
808.2	Closed fracture of pubis
808.3	Open fracture of pubis
808.41	Closed fracture of ilium
808.42	Closed fracture of ischium
808.43	Multiple closed pelvic fractures with disruption of pelvic circle
808.44	Multiple closed pelvic fractures without disruption of pelvic circle
808.49	Closed fracture of other specified part of pelvis
808.51	Open fracture of ilium
808.52	Open fracture of ischium
808.53	Multiple open pelvic fractures with disruption of pelvic circle
808.54	Multiple open pelvic fractures without disruption of pelvic circle
808.59	Open fracture of other specified part of pelvis

APPENDIX A: EXCLUSION DEFINITIONS (CONTINUED)

ICD-9-CM Code	Description
808.8	Unspecified closed fracture of pelvis
808.9	Unspecified open fracture of pelvis
820.00	Fracture of unspecified intracapsular section of neck of femur, closed
820.01	Fracture of epiphysis (separation) (upper) of neck of femur, closed
820.02	Fracture of midcervical section of neck of femur, closed
820.03	Fracture of base of neck of femur, closed
820.09	Other transcervical fracture of neck of femur, closed
820.10	Fracture of unspecified intracapsular section of neck of femur, open
820.11	Fracture of epiphysis (separation) (upper) of neck of femur, open
820.12	Fracture of midcervical section of neck of femur, open
820.13	Fracture of base of neck of femur, open
820.19	Other transcervical fracture of neck of femur, open
820.20	Fracture of unspecified trochanteric section of femur, closed
820.21	Fracture of intertrochanteric section of femur, closed
820.22	Fracture of subtrochanteric section of femur, closed
820.30	Fracture of unspecified trochanteric section of femur, open
820.31	Fracture of intertrochanteric section of femur, open
820.32	Fracture of subtrochanteric section of femur, open
820.8	Fracture of unspecified part of neck of femur, closed
820.9	Fracture of unspecified part of neck of femur, open
821.00	Fracture of unspecified part of femur, closed
821.01	Fracture of shaft of femur, closed
821.10	Fracture of unspecified part of femur, open
821.11	Fracture of shaft of femur, open
821.20	Fracture of lower end of femur, unspecified part, closed
821.21	Fracture of femoral condyle, closed
821.22	Fracture of lower epiphysis of femur, closed
821.23	Supracondylar fracture of femur, closed
821.29	Other fracture of lower end of femur, closed
821.30	Fracture of lower end of femur, unspecified part, open
821.31	Fracture of femoral condyle, open
821.32	Fracture of lower epiphysis of femur, open
821.33	Supracondylar fracture of femur, open
821.39	Other fracture of lower end of femur, open
Procedures (any position)	
00.70	Revision of hip replacement, both acetabular and femoral components
00.71	Revision of hip replacement, acetabular component
00.72	Revision of hip replacement, femoral component
00.73	Revision of hip replacement, acetabular liner and/or femoral head only
00.80	Revision of knee replacement, total (all components)
00.81	Revision of knee replacement, tibial component
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)
00.85	Resurfacing hip, total, acetabulum and femoral head
00.86	Resurfacing hip, partial, femoral head

APPENDIX A: EXCLUSION DEFINITIONS (CONTINUED)

ICD-9-CM Code	Description
00.87	Resurfacing hip, partial, acetabulum
78.65	Removal of implanted devices from bone, femur
78.66	Removal of implanted devices from bone, patella
78.67	Removal of implanted devices from bone, tibia and fibula
80.05	Arthrotomy for removal of prosthesis without replacement, hip
80.06	Arthrotomy for removal of prosthesis without replacement, knee
80.09	Arthrotomy for removal of prosthesis without replacement, other specified sites
81.52	Partial hip replacement
81.53	Revision of hip replacement, NOS
81.55	Revision of knee replacement, NOS
81.59	Revision of joint replacement of lower extremity, not elsewhere classified

**TABLE A2. MS-DRG CRITERIA FOR ELECTIVE KNEE AND HIP REPLACEMENT
STUDY POPULATION DEFINITION**

MS-DRGs *Not Excluded* from the Study

MS-DRG 003	ECMO or Tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R.
MS-DRG 461	Bilateral or Multiple Major Joint Procedures of Lower Extremity with MCC
MS-DRG 462	Bilateral or Multiple Major Joint Procedures of Lower Extremity without MCC
MS-DRG 463	Wound Debridement and Skin Graft Except Hand, for Musculo-Connective Tissue Disorders with MCC
MS-DRG 464	Wound Debridement and Skin Graft Except Hand, for Musculo-Connective Tissue Disorders with CC
MS-DRG 465	Wound Debridement and Skin Graft Except Hand, for Musculo-Connective Tissue Disorders without CC/MCC
MS-DRG 469	Major Joint Replacement or Reattachment of Lower Extremity with MCC
MS-DRG 470	Major Joint Replacement or Reattachment of Lower Extremity without MCC

APPENDIX B: COMPLICATION DEFINITION

FOR THE COMPLICATIONS LISTED BELOW

Follow up period: Complication occurred **during the index admission or within 7 days** of the index admission date.

Code placement:

- **Index hospitalizations.** For a complication that occurred during the index hospitalization, the complication code must be in a secondary diagnosis position and *not* coded as present on admission.
- **Readmissions.** For a complication identified during a readmission, the complication code must be the principal diagnosis of the readmission.

ICD-9-CM Code	Description
Acute myocardial infarction	
410.00	Acute myocardial infarction of anterolateral wall, episode of care unspecified
410.01	Acute myocardial infarction of anterolateral wall, initial episode of care
410.10	Acute myocardial infarction of other anterior wall, episode of care unspecified
410.11	Acute myocardial infarction of other anterior wall, initial episode of care
410.20	Acute myocardial infarction of inferolateral wall, episode of care unspecified
410.21	Acute myocardial infarction of inferolateral wall, initial episode of care
410.30	Acute myocardial infarction of inferoposterior wall, episode of care unspecified
410.31	Acute myocardial infarction of inferoposterior wall, initial episode of care
410.40	Acute myocardial infarction of other inferior wall, episode of care unspecified
410.41	Acute myocardial infarction of other inferior wall, initial episode of care
410.50	Acute myocardial infarction of other lateral wall, episode of care unspecified
410.51	Acute myocardial infarction of other lateral wall, initial episode of care
410.60	True posterior wall infarction, episode of care unspecified
410.61	True posterior wall infarction, initial episode of care
410.70	Subendocardial infarction, episode of care unspecified
410.71	Subendocardial infarction, initial episode of care
410.80	Acute myocardial infarction of other specified sites, episode of care unspecified
410.81	Acute myocardial infarction of other specified sites, initial episode of care
410.90	Acute myocardial infarction of unspecified site, episode of care unspecified
410.91	Acute myocardial infarction of unspecified site, initial episode of care
Pneumonia	
480.0	Pneumonia due to adenovirus
480.1	Pneumonia due to respiratory syncytial virus
480.2	Pneumonia due to parainfluenza virus
480.3	Pneumonia due to SARS-associated coronavirus
480.8	Pneumonia due to other virus not elsewhere classified
480.9	Viral pneumonia, unspecified
481	Pneumococcal pneumonia (<i>Streptococcus pneumoniae</i> pneumonia)
482.0	Pneumonia due to <i>Klebsiella pneumoniae</i>
482.1	Pneumonia due to <i>Pseudomonas</i>

APPENDIX B: COMPLICATION DEFINITION (CONTINUED)

FOR THE COMPLICATIONS LISTED BELOW

Follow up period: Complication occurred **during the index admission or within 7 days** of the index admission date.

Code placement:

- **Index hospitalizations.** For a complication that occurred during the index hospitalization, the complication code must be in a secondary diagnosis position and *not* coded as present on admission.
- **Readmissions.** For a complication identified during a readmission, the complication code must be the principal diagnosis of the readmission.

ICD-9-CM Code	Description
Pneumonia (continued)	
482.2	Pneumonia due to <i>Hemophilus influenzae</i> (<i>H. influenzae</i>)
482.30	Pneumonia due to Streptococcus, unspecified
482.31	Pneumonia due to Streptococcus, group A
482.32	Pneumonia due to Streptococcus, group B
482.39	Pneumonia due to other Streptococcus
482.40	Pneumonia due to Staphylococcus, unspecified
482.41	Methicillin susceptible pneumonia due to <i>Staphylococcus aureus</i>
482.42	Methicillin resistant pneumonia due to <i>Staphylococcus aureus</i>
482.49	Other Staphylococcus pneumonia
482.81	Pneumonia due to anaerobes
482.82	Pneumonia due to <i>Escherichia coli</i> [<i>E. coli</i>]
482.83	Pneumonia due to other gram-negative bacteria
482.84	Pneumonia due to Legionnaires' disease
482.89	Pneumonia due to other specified bacteria
482.9	Bacterial pneumonia, unspecified
483.0	Pneumonia due to <i>mycoplasma pneumoniae</i>
483.1	Pneumonia due to chlamydia
483.8	Pneumonia due to other specified organism
485	Bronchopneumonia, organism unspecified
486	Pneumonia, organism unspecified
487.0	Influenza with pneumonia
488.11	Influenza due to identified 2009 H1N1 influenza virus with pneumonia
507.0	Pneumonitis due to inhalation of food or vomitus
997.32	Postprocedural aspiration pneumonia
Sepsis/septicemia/shock	
038.0	Streptococcal septicemia
038.10	Staphylococcal septicemia, unspecified
038.11	Methicillin susceptible Staphylococcus aureus septicemia
038.12	Methicillin resistant Staphylococcus aureus septicemia
038.19	Other staphylococcal septicemia
038.2	Pneumococcal septicemia [Streptococcus pneumoniae septicemia]

APPENDIX B: COMPLICATION DEFINITION (CONTINUED)

FOR THE COMPLICATIONS LISTED BELOW

Follow up period: Complication occurred **during the index admission or within 7 days** of the index admission date.

Code placement:

- **Index hospitalizations.** For a complication that occurred during the index hospitalization, the complication code must be in a secondary diagnosis position and *not* coded as present on admission.
- **Readmissions.** For a complication identified during a readmission, the complication code must be the principal diagnosis of the readmission.

ICD-9-CM Code	Description
Sepsis/septicemia/shock (continued)	
038.3	Septicemia due to anaerobes
038.40	Septicemia due to gram negative organism, unspecified
038.41	Septicemia due to hemophilus influenzae [H. influenzae]
038.42	Septicemia due to escherichia coli [E. coli]
038.43	Septicemia due to pseudomonas
038.44	Septicemia due to serratia
038.49	Other septicemia due to gram-negative organisms
038.8	Other specified septicemias
038.9	Unspecified septicemia
785.52	Septic shock
785.59	Other shock without trauma
790.7	Bacteremia
995.91	Sepsis
995.92	Severe sepsis
998.00	Postoperative shock, unspecified
998.01	Postoperative shock, cardiogenic
998.02	Postoperative shock, septic
998.09	Postoperative shock, other

APPENDIX B: COMPLICATION DEFINITION (CONTINUED)

FOR THE COMPLICATIONS LISTED BELOW

Follow-up period: Complication occurred **during the index** admission or **within 30 days** of the index admission date.

Code placement:

- **Index hospitalizations.** For a complication that occurred during the index hospitalization, the complication code must be in a secondary diagnosis position and *not* coded as present on admission.
- **Readmissions.** For a complication identified during a readmission, the complication code must be the principal diagnosis of the readmission.

ICD-9-CM Code	Description
Surgical site bleeding	
<i>One of the following diagnosis codes</i>	
719.10	Hemarthrosis, site unspecified
719.16	Hemarthrosis, lower leg
719.17	Hemarthrosis, ankle and foot
998.11	Hemorrhage complicating a procedure
998.12	Hematoma complicating a procedure
998.13	Seroma complicating a procedure
<i>AND one of the following procedure codes</i>	
39.98	Control of hemorrhage, not otherwise specified
86.04	Other incision with drainage of skin and subcutaneous tissue
Pulmonary embolism	
415.11	Iatrogenic pulmonary embolism and infarction
415.13	Saddle embolus of pulmonary artery
415.19	Other pulmonary embolism and infarction

Death

Follow-up period: Death occurred **during the index** admission **or** after discharge from the index hospitalization but **within 30 days** of the index admission date.

APPENDIX B: COMPLICATION DEFINITION (CONTINUED)

FOR THE COMPLICATIONS LISTED BELOW

Follow-up period: Complication occurred **during the index admission or within 90 days** of the index admission date.

Code placement:

- **Index hospitalizations.** For a complication that occurred during the index hospitalization, the complication code must be in a secondary diagnosis position and *not* coded as present on admission.
- **Readmissions.** For a complication identified during a readmission, the complication code must be the principal diagnosis of the readmission.

ICD-9-CM Code	Description
Mechanical complications	
996.40	Unspecified mechanical complication of internal orthopedic device, implant, and graft
996.41	Mechanical loosening of prosthetic joint
996.42	Dislocation of prosthetic joint
996.44	Periprosthetic fracture around prosthetic joint
996.47	Other mechanical complication of prosthetic joint implant
996.49	Other mechanical complication of other internal orthopedic device, implant, and graft
Periprosthetic joint infection / wound infection	
One of the following diagnosis codes	
996.66	Infection and inflammatory reaction due to internal joint prosthesis
996.67	Infection and inflammatory reaction due to other internal orthopedic device, implant, and graft
998.30	Disruption of wound, unspecified
998.31	Disruption of internal operation (surgical) wound
998.32	Disruption of external operation (surgical) wound
998.33	Disruption of traumatic injury wound repair Infected postoperative seroma
998.51	Infected postoperative seroma
998.59	Other postoperative infection
998.6	Persistent postoperative fistula
998.83	Non-healing surgical wound
AND one of the following procedure codes	
00.70	Revision of hip replacement, both acetabular and femoral components
00.71	Revision of hip replacement, acetabular component
00.72	Revision of hip replacement, femoral component
00.73	Revision of hip replacement, acetabular liner and/or femoral head only
00.80	Replacement knee replacement, total (all components)
00.81	Replacement of knee replacement, tibial component
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)
78.65	Removal of implanted devices from bone, femur
78.66	Removal of implanted devices from bone, patella
78.67	Removal of implanted devices from bone, tibia and fibula

APPENDIX B: COMPLICATION DEFINITION (CONTINUED)

FOR THE COMPLICATIONS LISTED BELOW

Follow-up period: Complication occurred **during the index admission or within 90 days** of the index admission date.

Code placement:

- **Index hospitalizations.** For a complication that occurred during the index hospitalization, the complication code must be in a secondary diagnosis position and *not* coded as present on admission.
- **Readmissions.** For a complication identified during a readmission, the complication code must be the principal diagnosis of the readmission.

ICD-9-CM Code	Description
Periprosthetic joint infection / wound infection (continued)	
80.05	Arthrotomy for removal of prosthesis without replacement, hip
80.06	Arthrotomy for removal of prosthesis without replacement, knee
80.09	Arthrotomy for removal of prosthesis without replacement, other specified sites
81.53	Revision of hip replacement, not otherwise specified
81.55	Revision of knee replacement, not otherwise specified
81.59	Revision of joint replacement of lower extremity, not elsewhere classified
86.04	Other incision with drainage of skin and subcutaneous tissue
86.22	Excisional debridement of wound, infection, or burn
86.28	Non-excisional debridement of wound, infection or burn

APPENDIX C: DEFINITIONS FOR ICD-9-CM CODE-BASED POTENTIAL RISK FACTORS

Potential Risk Factor	ICD-9-CM Codes (in any diagnosis/procedure position unless noted otherwise)
Alcohol-related Disorders	291.0, 291.1, 291.2, 291.3, 291.5, 291.81, 291.82, 291.89, 291.9, 303.00, 303.01, 303.02, 303.90, 303.91, 303.92, 305.00, 305.01, 305.02
Anemia	280.1, 280.8, 280.9, 281.0, 281.1, 281.2, 281.3, 281.4, 281.8, 281.9, 282.0, 282.1, 282.2, 282.3, 282.40, 282.41, 282.42, 282.43, 282.44, 282.45, 282.46, 282.47, 282.49, 282.5, 282.60, 282.61, 282.62, 282.63, 282.64, 282.68, 282.69, 282.7, 282.8, 282.9, 283.0, 283.10, 283.11, 283.19, 283.2, 283.9, 284.01, 284.09, 284.11, 284.12, 284.19, 284.2, 284.81, 284.89, 284.9, 285.0, 285.21, 285.22, 285.29, 285.3, 285.8
Arthritis, Infective	711.05, 711.06, 711.95, 711.96, 730.15, 730.16
Arthritis, Rheumatoid and Inflammatory Joint Disease	696.0, 714.0, 714.1, 714.2, 714.30, 714.31, 714.32, 714.33, 714.4, 714.89, 714.9
Aseptic Necrosis of Knee/Hip Joint	733.42, 733.43
Asthma	493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.90, 493.91, 493.92
Atrial Fibrillation and Flutter	427.31, 427.32
Cancer	140.0-209.36, 209.70-209.79, 230.0-239.9
Cardiomyopathy	425.0, 425.11, 425.18, 425.3, 425.4, 425.5, 425.7, 425.8, 425.9, 429.1, 429.3
Cerebrovascular Disease	433.00, 433.10, 433.20, 433.30, 433.80, 433.90, 434.00, 434.10, 434.90, 436, 437.0, 437.1, 437.2, 437.3, 437.4, 442.81
Chronic Deep Vein Thrombosis Lower Extremity	453.50, 453.51, 453.52
Chronic Kidney Disease	403.00, 403.01, 403.10, 403.11, 403.90, 403.91, 404.00, 404.02, 404.10, 404.12, 404.90, 404.92, 585.1, 585.2, 585.3, 585.4, 585.5, 585.6, 585.9, V45.11
Chronic Lung Disease	135, 491.0, 491.1, 491.20, 491.21, 491.22, 491.8, 491.9, 492.0, 492.8, 493.20, 493.21, 493.22, 494.0, 494.1, 496, 500, 501, 502, 503, 504, 505, 506.4, 508.1, 515, 516.31, 516.32, 516.34, 518.2, 518.83
Chronic Pulmonary Embolism	416.2
Chronic Pulmonary Heart Disease	416.0, 416.1, 416.8, 416.9
Coagulopathy	286.0, 286.1, 286.2, 286.3, 286.4, 287.30, 287.31, 287.32, 287.33, 287.39, 289.81
Cognitive Impairment	290.0, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.40, 290.41, 290.42, 290.43, 290.8, 290.9, 294.20, 294.21, 294.8, 294.9, 310.0, 310.1, 310.2, 310.81, 310.89, 310.9, 317, 318.0, 318.1, 318.2, 319, 331.83, V15.52
Congenital Anomaly	740.0, 740.1, 740.2, 741.00, 741.01, 741.02, 741.03, 741.90, 741.91, 741.92, 741.93, 742.0, 742.1, 742.2, 742.3, 742.4, 742.51, 742.53, 742.59, 742.8, 742.9, 745.0, 745.10, 745.11, 745.12, 745.19, 745.2, 745.3, 745.4, 745.5, 745.60, 745.61, 745.69, 745.7, 745.8, 745.9, 746.01, 746.02, 746.09, 746.1, 746.2, 746.3, 746.4, 746.5, 746.6, 746.7, 746.81, 746.82, 746.83, 746.84, 746.85, 746.86, 746.87, 746.89, 746.9, 747.0, 747.10, 747.11, 747.20, 747.21, 747.22, 747.29, 747.31, 747.32, 747.39, 747.40, 747.41, 747.42, 747.49, 747.5, 747.60, 747.61, 747.62, 747.63, 747.64, 747.69, 747.81, 747.82, 747.83, 747.89, 747.9, 748.3, 748.4, 748.5, 748.60, 748.61, 748.69, 748.8, 748.9, 751.0, 751.1, 751.2, 751.3, 751.4, 751.5, 751.60, 751.61, 751.62, 751.69, 751.7, 751.8, 751.9, 753.0, 753.10, 753.11, 753.12, 753.13, 753.14, 753.15, 753.16, 753.17, 753.19, 753.20, 753.21, 753.22, 753.23, 753.29, 753.3, 753.4, 753.5, 753.6, 753.7, 753.8, 753.9, 758.0, 758.1, 758.2, 758.31, 758.32, 758.33, 758.39, 758.4, 758.5, 758.6, 758.7, 758.81, 758.89, 758.9, 759.7, 759.81, 759.82, 759.83, 759.89, 759.9, 760.71, 760.72, 760.73,

APPENDIX C: DEFINITIONS FOR ICD-9-CM CODE-BASED POTENTIAL RISK FACTORS (CONTINUED)

Potential Risk Factor	ICD-9-CM Codes (in any diagnosis/procedure position unless noted otherwise)
	760.75, 760.76, 760.77, 760.78, 771.0, 771.1, 775.1
Coronary Artery Disease	412, 414.00, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.2, 414.3, 414.4, 414.8, 414.9, 429.2
Crohn's Disease and Regional Enteritis	555.0, 555.1, 555.2, 555.9, 556.0, 556.1, 556.2, 556.3, 556.4, 556.5, 556.6, 556.8, 556.9
Deformity of Knee/Hip Joint, Acquired	094.0
Deformity of Musculoskeletal System, Congenital	754.2, 754.30, 754.31, 754.32, 754.33, 754.35, 754.40, 754.41, 754.42, 754.43, 754.44, 754.50, 754.51, 754.52, 754.53, 754.59, 755.60, 755.61, 755.62, 755.63, 755.64, 755.65, 755.66, 755.67, 755.69
Deformity of Spine, Acquired	737.10, 737.11, 737.12, 737.19, 737.20, 737.21, 737.22, 737.29, 737.30, 737.31, 737.32, 737.33, 737.34, 737.39, 737.40, 737.41, 737.42, 737.43, 737.8, 737.9
Degenerative Diseases of Musculoskeletal System	718.55, 718.56, 720.0, 720.1, 720.2, 720.81, 720.89, 720.9, 721.0, 721.1, 721.2, 721.3, 721.41, 721.42, 721.5, 721.6, 721.7, 721.8, 721.90, 721.91
Diabetes	249.00, 249.01, 249.10, 249.11, 249.20, 249.21, 249.30, 249.31, 249.40, 249.41, 249.50, 249.51, 249.60, 249.61, 249.70, 249.71, 249.80, 249.81, 249.90, 249.91, 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93
Diseases of Bone and Cartilage	730.70, 731.0, 731.1, 731.3, 731.8, 732.1, 732.4, 732.7, 732.8, 732.9
Diseases of Central Nervous System, Hereditary/Degenerative	330.1, 330.2, 330.3, 330.8, 330.9, 331.0, 331.11, 331.19, 331.2, 331.3, 331.4, 331.5, 331.6, 331.7, 331.81, 331.82, 331.89, 331.9, 332.0, 333.0, 333.4, 333.5, 333.6, 334.0, 334.1, 334.2, 334.3, 334.4, 334.8, 334.9, 335.0, 335.10, 335.11, 335.19, 335.20, 335.21, 335.22, 335.23, 335.24, 335.29, 335.8, 335.9, 336.0, 336.1, 336.2, 336.3, 336.8, 336.9, 337.20, 337.21, 337.22, 337.29, 337.3, 337.9, 340, 341.0, 341.1, 341.8, 341.9
Diseases of Knee/Hip Joint	094.0, 274.00, 274.01, 274.02, 274.03, 713.5, 716.15, 716.16, 716.55, 716.56, 716.85, 716.86, 716.95, 716.96
Disorders of Joint, Muscle, and Ligament	718.35, 718.36, 718.45, 718.46, 726.5, 726.60, 726.61, 726.62, 726.63, 726.64, 726.65, 726.69, 728.2, 728.3, 728.4, 728.5, 728.87
Drug-related Disorders	292.0, 292.11, 292.12, 292.2, 292.81, 292.82, 292.83, 292.84, 292.85, 292.89, 292.9, 304.00, 304.01, 304.02, 304.10, 304.11, 304.12, 304.20, 304.21, 304.22, 304.30, 304.31, 304.32, 304.40, 304.41, 304.42, 304.50, 304.51, 304.52, 304.60, 304.61, 304.62, 304.70, 304.71, 304.72, 304.80, 304.81, 304.82, 304.90, 304.91, 304.92, 305.20, 305.21, 305.22, 305.30, 305.31, 305.32, 305.40, 305.41, 305.42, 305.50, 305.51, 305.52, 305.60, 305.61, 305.62, 305.70, 305.71, 305.72, 305.80, 305.81, 305.82, 305.90, 305.91, 305.92
Electrolyte Imbalance	Diagnosis codes 276.0, 276.1, 276.2, 276.3, 276.4, 276.7, 276.8, 276.9 with a Present on Admission (POA) Indicator of Y (Yes) or W (Clinically Undetermined)
Environmental and Economic Factors	V60.0, V60.1, V60.2, V60.3, V60.4
Functional Impairment	780.72, 781.2, 781.3, V15.88, V46.3
Heart Failure	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9

APPENDIX C: DEFINITIONS FOR ICD-9-CM CODE-BASED POTENTIAL RISK FACTORS (CONTINUED)

Potential Risk Factor	ICD-9-CM Codes (in any diagnosis/procedure position unless noted otherwise)
Heart Valve Disease	394.0, 394.1, 394.2, 394.9, 395.0, 395.1, 395.2, 395.9, 396.0, 396.1, 396.2, 396.3, 396.8, 396.9, 397.0, 397.1, 424.0, 424.1, 424.2, 424.3
History of Cancer	V10.00, V10.01, V10.02, V10.03, V10.04, V10.05, V10.06, V10.07, V10.09, V10.11, V10.12, V10.20, V10.21, V10.22, V10.29, V10.3, V10.40, V10.41, V10.42, V10.43, V10.44, V10.45, V10.46, V10.47, V10.48, V10.49, V10.50, V10.51, V10.52, V10.53, V10.59, V10.60, V10.61, V10.62, V10.63, V10.69, V10.71, V10.72, V10.79, V10.81, V10.82, V10.83, V10.84, V10.85, V10.86, V10.87, V10.88, V10.89, V10.90, V10.91
History of Coronary and Valve Procedures	V42.2, V43.3, V45.81, V45.82
History of Knee and Hip Joint Replacement	V43.64, V43.65
History of Lower Extremity Amputation	V49.70, V49.71, V49.72, V49.73, V49.74, V49.75, V49.76, V49.77
History of Non-Compliance with Medical Treatment	V15.81, V45.12
History of Pacemaker or Defibrillator	V45.01, V45.02, V53.31, V53.32, V53.39
History of Stroke	438.0, 438.10, 438.11, 438.12, 438.13, 438.14, 438.19, 438.20, 438.21, 438.22, 438.30, 438.31, 438.32, 438.40, 438.41, 438.42, 438.50, 438.51, 438.52, 438.53, 438.6, 438.7, 438.81, 438.82, 438.83, 438.84, 438.85, 438.89, 438.9, V12.54
History of Thrombosis or Embolism	V12.51, V12.55
Hypertension, Essential	401.1, 401.9
Hypertension, Malignant and Secondary	401.0, 402.00, 402.10, 402.90, 405.01, 405.09, 405.11, 405.19, 405.91, 405.99
Immunity Disorder	042, 279.00, 279.01, 279.02, 279.03, 279.04, 279.05, 279.06, 279.09, 279.10, 279.11, 279.12, 279.13, 279.19, 279.2, 279.3, 279.41, 279.49, 279.50, 279.51, 279.52, 279.53, 279.8, 279.9, 710.0, 710.1, V42.0, V42.1, V42.6, V42.7, V42.81, V42.82, V42.83, V42.84, V42.89, V42.9 Principal diagnosis: 996.80, 996.81, 996.82, 996.83, 996.84, 996.85, 996.86, 996.87, 996.88, 996.89 Procedures prior to knee/hip replacement: 00.18, 33.50, 33.51, 33.52, 33.6, 37.51, 37.52, 37.53, 41.00, 41.02, 41.03, 41.05, 41.06, 41.08, 41.94, 46.97, 50.51, 50.59, 52.80, 52.81, 52.82, 52.83, 52.85, 52.86, 55.69
Liver Disease	070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.70, 070.71, 456.0, 456.1, 456.20, 456.21, 571.0, 571.1, 571.2, 571.3, 571.40, 571.41, 571.42, 571.49, 571.5, 571.6, 571.8, 571.9, 572.3, 572.4, 572.8, 573.0, 573.1, 573.2, 573.3, 573.4, 573.5, 573.8, 573.9
Long-term (current) Use of Antiplatelets and Antithrombotics	V58.61, V58.63
Long-term (current) Use of Insulin	V58.67
Long-term (current) Use of Steroids	V58.65
Lower Extremity Ulcer	707.10, 707.11, 707.12, 707.13, 707.14, 707.15, 707.19
Malnutrition	261, 262, 263.0, 263.1, 263.2, 263.8, 263.9, 799.4, V85.0
Mental Disorders	295.00-295.95, 296.00-296.99, 297.0, 297.1, 297.2, 297.3, 297.8, 297.9, 298.0, 298.1, 298.4, 298.8, 298.9, 299.00, 299.01, 299.10, 299.11, 299.80, 299.81, 299.90, 299.91, 300.00, 300.01, 300.02, 300.09, 300.10, 300.11, 300.12, 300.13, 300.14, 300.15, 300.16, 300.19, 300.20, 300.21, 300.22, 300.23, 300.29, 300.3, 300.4, 300.5, 300.6, 300.7, 300.81, 300.82, 300.89, 300.9, 301.0, 301.10, 301.11, 301.12, 301.13, 301.20, 301.21, 301.22, 301.3, 301.4, 309.1, 309.81, 311

APPENDIX C: DEFINITIONS FOR ICD-9-CM CODE-BASED POTENTIAL RISK FACTORS (CONTINUED)

Potential Risk Factor	ICD-9-CM Codes (in any diagnosis/procedure position unless noted otherwise)
Morbid Obesity	278.01, V85.39, V85.41, V85.42, V85.43, V85.44, V85.45
Muscular Dystrophy	359.0, 359.1, 359.21, 359.22, 359.23, 359.29
Myasthenia/Myoneural Disorders	358.00, 358.01, 358.1, 358.30, 358.31, 358.39, 358.8, 358.9
Obesity	278.00, V85.30, V85.31, V85.32, V85.33, V85.34, V85.35, V85.36, V85.37, V85.38, V85.54
Obstructive Sleep Apnea and Obesity-Related Hypoventilation Syndrome	278.03, 327.23
Osteoporosis	733.00, 733.01, 733.02, 733.03, 733.09
Oxygen Therapy Dependence (long-term)	V46.2
Paralysis and Palsy	138, 342.00, 342.01, 342.02, 342.10, 342.11, 342.12, 342.80, 342.81, 342.82, 342.90, 342.91, 342.92, 343.0, 343.1, 343.2, 343.3, 343.4, 343.8, 343.9, 344.00, 344.01, 344.02, 344.03, 344.04, 344.09, 344.1, 344.2, 344.30, 344.31, 344.32, 344.40, 344.41, 344.42, 344.5, 344.89, 344.9
Peripheral Vascular Disease	440.0, 440.1, 440.20, 440.21, 440.22, 440.23, 440.24, 440.29, 440.30, 440.31, 440.32, 440.4, 440.8, 440.9, 441.2, 441.4, 441.7, 441.9, 442.0, 442.1, 442.2, 442.3, 442.82, 442.83, 442.84, 443.0, 443.1, 443.81, 443.82, 443.89, 443.9, 447.70, 447.71, 447.72, 447.73, 453.71, 453.72, 453.73, 453.74, 453.75, 453.76, 453.77, 453.79, 454.0, 454.1, 454.2, 454.8, 454.9, 459.30, 459.31, 459.32, 459.33, 459.39, 459.81, 557.1, 593.81
Polyneuropathy	356.0, 356.1, 356.2, 356.3, 356.4, 356.8, 356.9, 357.1, 357.2, 357.3, 357.4, 357.5, 357.81
Tobacco Use	305.1
Visual Impairment	369.00, 369.01, 369.02, 369.03, 369.04, 369.05, 369.06, 369.07, 369.08, 369.10, 369.11, 369.12, 369.13, 369.14, 369.15, 369.16, 369.17, 369.18, 369.20, 369.21, 369.22, 369.23, 369.24, 369.25, 369.3, 369.4, 369.60, 369.61, 369.62, 369.63, 369.64, 369.65, 369.66, 369.67, 369.68, 369.69, 369.70, 369.71, 369.72, 369.73, 369.74, 369.75, 369.76, 369.8, 369.9

