



CALIFORNIA
JOINT REPLACEMENT
REGISTRY



ANNUAL REPORT 2016

Dedication

We gratefully dedicate the 2016 Annual Report to David Lansky, PhD at the Pacific Business Group on Health, Mark D. Smith, MD, MBA, founding president and chief executive officer at the California Health Care Foundation, and their many team members. Their vision, innovation, dedication, inspiration, and unwavering commitment to the California Joint Replacement Registry has led to a permanent home within the American Joint Replacement Registry.

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Foreword

From CJRR's Medical Director

We are pleased to present you with the 2016 Annual Report of the California Joint Replacement Registry (CJRR). The data presented in this report were collected between April 1, 2011 and June 17, 2016. Since our initial progress report was released in 2014, the volume of cases and surgeons in the CJRR continues to grow steadily. After eighteen months of planning, the merger between CJRR and the American Joint Replacement Registry (AJRR) has been successfully completed. We would like to recognize the many supporters of CJRR and AJRR who worked diligently to make it a smooth transition. I would like to personally thank Stephanie Teleki, PhD, Walter Sujansky, MD, PhD, and Zhongmin Li, PhD for their efforts in getting CJRR to this milestone.

CJRR plays a unique role because it collects and incorporates clinical information and direct feedback from patients about the outcomes of hip and knee replacements. CJRR is at the forefront of this work, as it is one of only a handful of multi-institutional, orthopaedic Level III registries in this country. (Level III registries include patient-reported outcome (PRO) data as well as payer, provider, clinical, surgical, laboratory, pharmacy, and device information.)

The CJRR is supported by many large purchasers and organizations of health care in California:

- Anthem, Blue Shield, and Cigna have provided funding to CJRR;
- Model contracts for Covered California, the state-run individual health insurance exchange, include CJRR;
- The PBGH Negotiating Alliance has included CJRR metrics in its selection criteria for its Center of Excellence programs; and
- The California Public Employees' Retirement System (CalPERS), an agency that manages health benefits for more than 1.6 million Californians, has highlighted CJRR participants in its member facing materials and on www.castlighthouse.com, indicating that CJRR participants collect patient-reported outcomes and participate in the registry.
- California Orthopaedic Association

In the PRO section, you will notice that more hospitals have contributed enough data to be included in this year's Annual Report. For the first time, we have included data on survey completion rates. The collection of PRO data remains challenging in the U.S. Fortunately, there are multiple entities tackling this problem through a variety of innovative solutions. Interestingly, all hospitals earned an average rating for the percentage

of patients able to achieve improvement in their scores at one year after the operation.

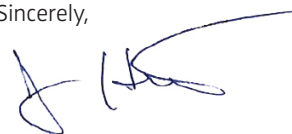
Progress is being made in our collaborations with Yale New Haven Health Services Corporation/Center for Outcomes Research and Evaluation (CORE) as well as with Blue Shield of California. The Yale CORE group has completed their analysis of our PRO data and their report will be released shortly. Blue Shield has engaged CJRR and the California Orthopaedic Association to assist with their pre-authorization program for hip and knee replacement, which began on April 1. We anticipate that our formal agreement will be finalized in the near future. As part of this collaboration, patients being cared for by CJRR surgeons at CJRR hospitals will be exempt from the pre-authorization program. In addition, we expect CJRR to play a significant role in collecting and disseminating the data collected from members of Blue Shield.

As part of our efforts to serve our participating surgeons and hospitals in the Comprehensive Care for Joint Replacement (CJR) program, on January 1, 2017, CJRR will offer collection of the Hip dysfunction and Osteoarthritis Outcome Score for Joint Replacement (HOOS, JR.) and the Knee injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS, JR.). This should greatly diminish the data collection burden for our patients.

On the research front, CJRR presented multiple papers at the recent annual meetings of the American Association of Hip and Knee Surgeons, the American Academy of Orthopaedic Surgeons, and the International Society for Arthroplasty Registers. In these studies, we examined variations in risk-adjusted hospital-expected complication rates after hip and knee arthroplasty. Current research projects include the evaluation of patient-reported outcomes with different surgical approaches, the relationship between complications at community versus academic hospitals and surgeons, and the exploration of socioeconomic risk adjustment. We now have a critical mass of data in CJRR, to help with your research proposals.

As always, thank you for your continued support of CJRR.

Sincerely,



James I. Huddleston, III, MD

Medical Director, California Joint Replacement Registry

About CJRR

The California Joint Replacement Registry (CJRR), established in 2009, collects and analyzes data from hip and knee replacement surgeries performed across California. In 2015, the time period covered in this report, 30 hospitals and 192 surgeons contributed data on the hip and knee replacements that were performed. CJRR is at the forefront of nationwide registries that routinely collect patient-reported outcomes (PROs), as well as clinical information and data about implanted devices. In 2015, CJRR announced an affiliation with the American Joint Replacement Registry (AJRR).

Figure 1: Cumulative Case Volume (N=23,690)

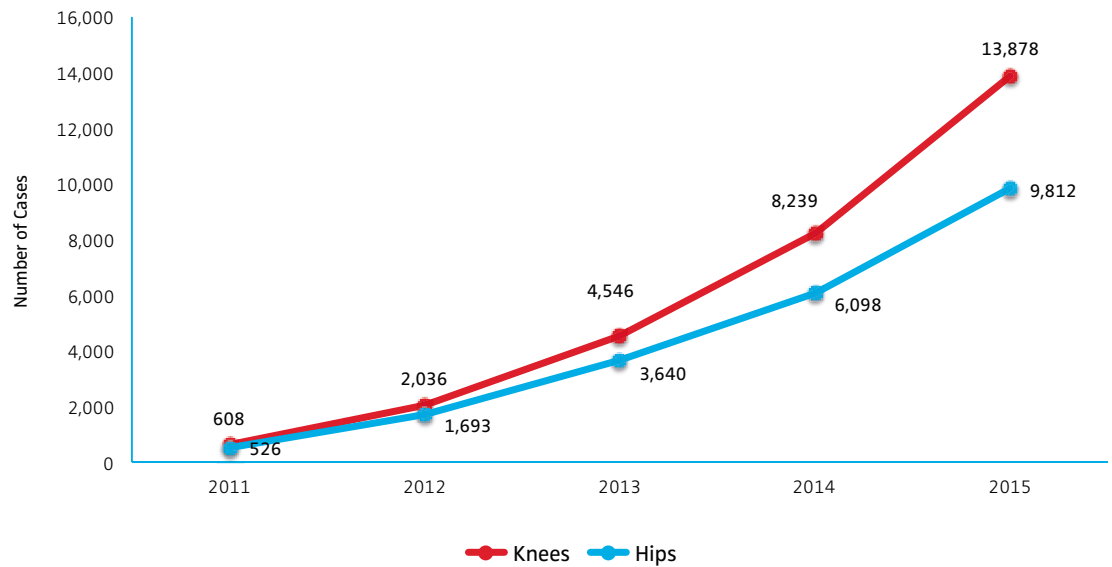
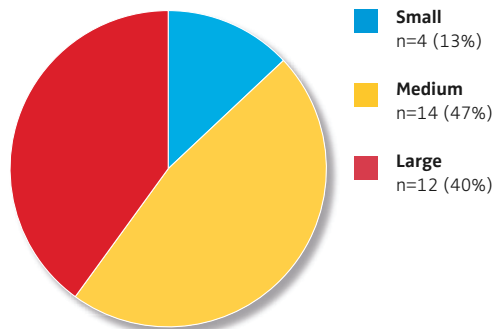


Figure 2: CJRR Hospital Participants by Size (N=30)



Source: California Office of Statewide Health Planning and Development (OSHPD)
Small = 1-99 beds; Medium = 100-399 beds; Large = 400+ beds

Table 1: Participants and Cases Reported through August 2016 (N=28,852)

Facility	Date Joined CJRR	Cases Reported
Alta Bates Summit Medical Center - Bates Campus	9/17/2012	371
Alta Bates Summit Medical Center - Summit Campus	9/17/2012	540
California Pacific Medical Center	10/16/2014	437
Cedars-Sinai Medical Center	5/9/2011	1,139
Dameron Hospital	11/5/2013	326
Eisenhower Medical Center	10/28/2013	1,440
Glendale Adventist Medical Center	10/1/2015	72
Hoag Orthopedic Institute	4/7/2011	9,328
John Muir Medical Center, Concord	12/18/2012	1,015
John Muir Medical Center, Walnut Creek	10/9/2012	2,112
Lodi Memorial Hospital	3/10/2014	223
Long Beach Memorial	10/6/2014	553
Memorial Medical Center	12/8/2014	255
Mercy General Hospital	4/22/2016	16
Methodist Hospital of Sacramento	3/18/2014	418
Mills-Peninsula Medical Center	4/1/2014	807
Novato Community Hospital	12/3/2014	239
Orange Coast Memorial	9/23/2014	716
PIH Health Hospital - Whittier	3/4/2013	1,271
Saddleback Memorial	9/30/2014	1,014
Scripps Green Hospital	8/19/2013	712
St. Bernardine Medical Center	10/15/2013	14
St. Helena Hospital Napa Valley	11/24/2015	63
St. Joseph Hospital	11/12/2012	471
St. Jude Medical Center	8/12/2013	356
Stanford Healthcare	9/12/2012	2,186
Sutter Medical Center, Sacramento	2/13/2013	111
Tahoe Forest Hospital District	3/10/2015	48
Tri-City Medical Center	4/15/2014	429
UCSF Medical Center	3/1/2011	2,170

Patient-Reported Outcomes

Table 2: PRO Completion Rates

Hospital Name	Patients Completing All 3 Surveys Pre-op [N]	Pre-op and 1 Year Opportunities [N]	Pre-op and 1 Year Completed [N]	Pre-op and 1 Year Completed [%]
Alta Bates Summit Medical Center - Bates Campus	401	299	136	45.5%
Alta Bates Summit Medical Center - Summit Campus	375	336	163	48.51%
California Pacific Medical Center	308	111	49	44.1%
Cedars-Sinai Medical Center	340	973	402	41.3%
Dameron Hospital	43	245	67	27.3%
Eisenhower Medical Center	915	640	505	78.9%
Hoag Orthopedic Institute*	0	6,712	0	11.7%*
John Muir Medical Center, Concord	273	540	248	45.9%
John Muir Medical Center, Walnut Creek	625	1,215	480	39.5%
Lodi Memorial Hospital	172	133	64	48.1%
Long Beach Memorial	138	221	94	42.5%
Memorial Medical Center	171	63	51	81.0%
Methodist Hospital of Sacramento	412	283	109	38.5%
Mills-Peninsula Medical Center	431	395	246	62.3%
Novato Community Hospital	136	83	35	42.2%
Orange Coast Memorial	115	311	94	30.2%
PIH Health Hospital - Whittier	398	805	147	18.3%
Saddleback Memorial	301	379	120	31.7%
Scripps Green Hospital	511	274	129	47.1%
St. Bernardine Medical Center	17	14	10	71.4%
St. Joseph Hospital	234	334	192	57.5%
St. Jude Medical Center	222	298	122	40.9%
Stanford Healthcare	789	1,493	503	33.7%
Sutter Medical Center, Sacramento	32	111	71	64.0%
Tahoe Forest Hospital District	8	26	0	0.0%
Tri-City Medical Center	304	202	146	72.3%
UCSF Medical Center	1,660	1,818	984	54.1%

* Hoag Orthopaedic Institute collects the 12-Item Short Form Survey (SF-12) instead of The Veterans Rand 12 Item Health Survey (VR-12). They had 11.7% of their eligible patients complete all three surveys pre-operatively and at one year post-operatively.

CJRR collects information directly from patients, using several standardized surveys.

- The Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC) assesses a patient’s hip and knee pain and function on a scale of 0 to 100, with 100 being maximum function and minimum pain, by asking questions related to a patient’s activities such as:
 - “How much pain do you have when walking on a flat surface?” “...or sitting?”
 - “How severe is your stiffness when you first wake up in the morning?”
 - “How much difficulty do you have when getting up from a sitting position?”
- The Veterans Rand 12-Item Health Survey (VR-12) assesses a patient’s general quality of life. As with the WOMAC, the VR-12 has a scale of 0 to 100, with 100 indicating a maximum positive score.

- The UCLA Activity Score surveys a patient’s hip and knee pain and function on a 10-point scale from a 1 – “wholly inactive: dependent upon others; cannot leave residence,” to a 5 – “sometimes participate in moderate activities,” to a 10 – “regularly participate in impact sports, such as jogging, tennis, skiing, acrobatics, ballet, heavy labor, or backpacking.”

CJRR offers multiple options for PRO survey completion. Patients can complete their PRO surveys online using a secure CJRR web-based interface (on a phone, computer, or tablet) or in a paper form that can be sent directly to CJRR via secure electronic fax. This reduces the administrative burden on surgeons and staff and ensures that PRO collection is uniform and complete.

PRO Results

Figure 3: WOMAC Hip and Knee Mean Scores Pre-Surgery and One Year Post-Surgery (N=17,080)

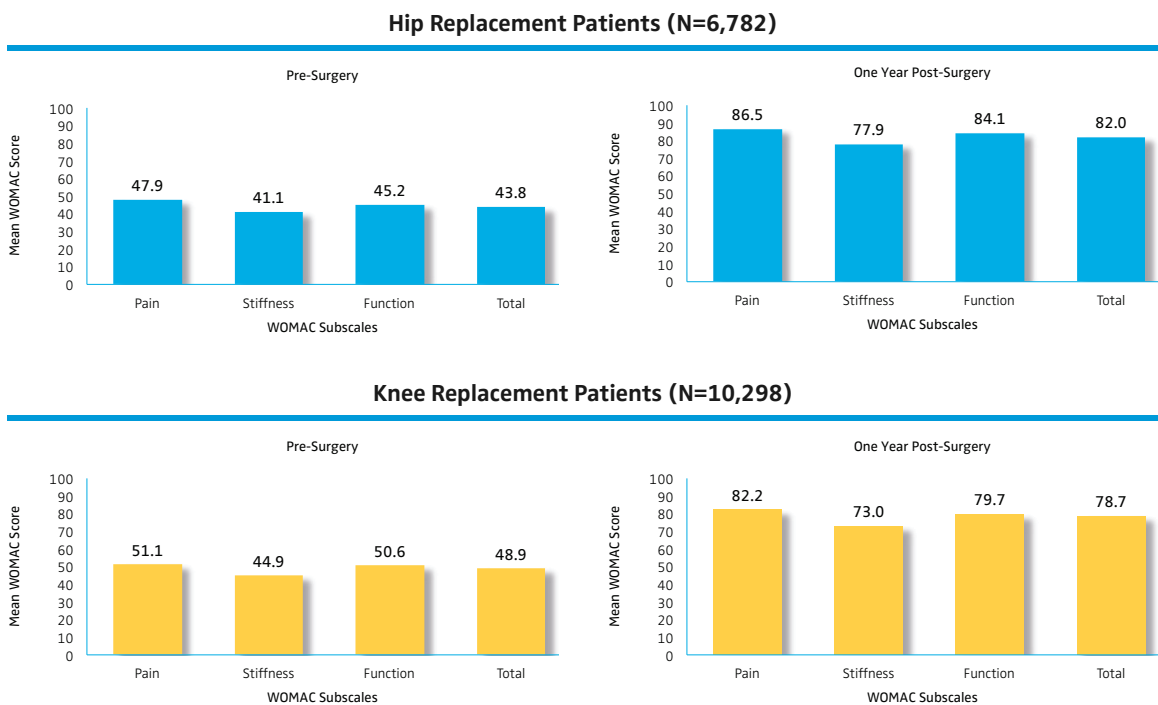


Table 3: Change in WOMAC Scores Pre-Surgery and One Year Post-Surgery, by Hospital*

Hospital Code	Count of Patients That Had Orthopedic Surgery, N	Count of Patients That Had Orthopedic Surgery and Completed a Survey about Their Physical Health before and after Surgery, N	Response Rate - Percentage of Patients Who Completed Pre-op and 1-Year WOMAC Total Score, %	Percent of Patients That Reported Meaningful Improvement in Their WOMAC Total Score after Surgery - Adjusted for Difference in Patient Health, %	Performance Rating
Overall	21,167	3,513	16.6		
Alta Bates Summit Medical Center - Bates Campus	327	80	24.5	81.1	★★★★★
Alta Bates Summit Medical Center - Summit Campus	428	88	20.6	86.4	★★★★★
California Pacific Medical Center	316	35	11.1	91.6	★★★★★
Cedars-Sinai Medical Center	879	122	13.9	86.8	★★★★★
Eisenhower Medical Center	1,091	420	38.5	90.9	★★★★★
Hoag Orthopedic Institute	7,205	635	8.8	90.0	★★★★★
John Muir Medical Center, Concord	808	93	11.5	90.5	★★★★★
John Muir Medical Center, Walnut Creek	1,569	184	11.7	88.7	★★★★★
Lodi Memorial Hospital	185	48	25.9	81.2	★★★★★
Long Beach Memorial	453	58	12.8	91.7	★★★★★
Memorial Medical Center	195	45	23.1	86.9	★★★★★
Methodist Hospital of Sacramento	369	95	25.7	87.3	★★★★★
Mills-Peninsula Medical Center	640	172	26.9	80.1	★★★★★
Orange Coast Memorial	562	31	5.5	81.6	★★★★★
PIH Health Hospital - Whittier	942	78	8.3	89.0	★★★★★
Saddleback Memorial	776	80	10.3	87.9	★★★★★
Scripps Green Hospital	294	93	31.6	90.1	★★★★★
St. Joseph Hospital	381	111	29.1	89.8	★★★★★
St. Jude Medical Center	328	85	25.9	89.5	★★★★★
Stanford Healthcare	1,259	181	14.4	87.4	★★★★★
Tri-City Medical Center	339	113	33.3	86.3	★★★★★
UCSF Medical Center	1,231	608	49.4	88.5	★★★★★

*For hospitals with >30 eligible patients who completed both pre-surgical and 1 year post-surgical PROs.

Figure 4: VR-12 Hip and Knee Scores for Physical and Mental Function, Pre-Surgery and One Year Post-Surgery for Hip and Knee Replacement Patients (N=19,106)

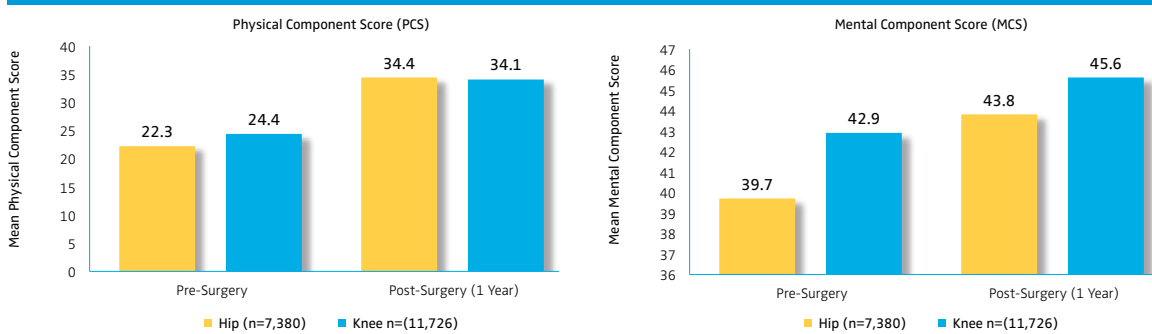


Table 4a: Change in VR-12 Physical Component Score*

Hospital Code	Count of Patients That Had Orthopedic Surgery, N	Count of Patients That Had Orthopedic Surgery and Completed a Survey about Their Physical Health before and after Surgery, N	Response Rate - Percentage of Patients Who Completed Pre-op and 1-Year VR-12 Physical Health Subscale Score, %	Percent of Patients That Reported Meaningful Improvement in Their Physical Health Score after Surgery - Adjusted for Difference in Patient Health, %	Performance Rating
Overall	13,962	2,922	20.9		
Alta Bates Summit Medical Center-Bates Campus	327	90	27.5	62.9	★★★★★
Alta Bates Summit Medical Center-Summit Campus	428	103	24.1	76.0	★★★★★
California Pacific Medical Center	316	35	11.1	71.8	★★★★★
Cedars-Sinai Medical Center	879	122	13.9	74.2	★★★★★
Eisenhower Medical Center	1,091	422	38.7	79.1	★★★★★
John Muir Medical Center, Concord	808	91	11.3	79.0	★★★★★
John Muir Medical Center, Walnut Creek	1,569	195	12.4	80.2	★★★★★
Lodi Memorial Hospital	185	48	25.9	76.2	★★★★★
Long Beach Memorial	453	55	12.1	85.3	★★★★★
Memorial Medical Center	195	44	22.6	66.6	★★★★★
Methodist Hospital of Sacramento	369	94	25.5	78.5	★★★★★
Mills-Peninsula Medical Center	640	166	25.9	66.9	★★★★★
PIH Health Hospital-Whittier	942	77	8.2	73.5	★★★★★
Saddleback Memorial	776	79	10.2	81.5	★★★★★
Scripps Green Hospital	294	90	30.6	84.7	★★★★★
St. Joseph Hospital	381	112	29.4	76.1	★★★★★
St. Jude Medical Center	328	90	27.4	74.5	★★★★★
Stanford Healthcare	1,259	185	14.7	72.2	★★★★★
Tri-City Medical Center	339	113	33.3	74.6	★★★★★
UCSF Medical Center	1,231	621	50.4	70.9	★★★★★

*For hospitals with >30 eligible patients who completed both pre-surgical and 1 year post-surgical PROs.

Table 4b: Change in VR-12 Mental Component Score*

Hospital Code	Count of Patients That Had Orthopedic Surgery, N	Count of Patients That Had Orthopedic Surgery and Completed a Survey about Their Physical Health before and after Surgery, N	Response Rate - Percentage of Patients Who Completed Pre-op and 1-Year VR-12 Mental Health Subscale, %	Percent of Patients That Reported Meaningful Improvement in Their Mental Health Score after Surgery - Adjusted for Difference in Patient Health, %	Performance Rating
Overall	13,962	2,922	20.9		
Alta Bates Summit Medical Center-Bates Campus	327	90	27.5	31.0	★★★★★
Alta Bates Summit Medical Center-Summit Campus	428	103	24.1	32.9	★★★★★
California Pacific Medical Center	316	35	11.1	30.1	★★★★★
Cedars-Sinai Medical Center	879	122	13.9	39.5	★★★★★
Eisenhower Medical Center	1,091	422	38.7	43.4	★★★★★
John Muir Medical Center, Concord	808	91	11.3	38.2	★★★★★
John Muir Medical Center, Walnut Creek	1,569	195	12.4	39.6	★★★★★
Lodi Memorial Hospital	185	48	25.9	27.7	★★★★★
Long Beach Memorial	453	55	12.1	48.0	★★★★★
Memorial Medical Center	195	44	22.6	49.2	★★★★★
Methodist Hospital of Sacramento	369	94	25.5	41.3	★★★★★
Mills-Peninsula Medical Center	640	166	25.9	35.3	★★★★★
PIH Health Hospital-Whittier	942	77	8.2	44.3	★★★★★
Saddleback Memorial	776	79	10.2	45.2	★★★★★
Scripps Green Hospital	294	90	30.6	37.6	★★★★★
St. Joseph Hospital	381	112	29.4	45.1	★★★★★
St. Jude Medical Center	328	90	27.4	38.2	★★★★★
Stanford Healthcare	1,259	185	14.7	42.0	★★★★★
Tri-City Medical Center	339	113	33.3	38.5	★★★★★
UCSF Medical Center	1,231	621	50.4	36.8	★★★★★

*For hospitals with >30 eligible patients who completed both pre-surgical and 1 year post-surgical PROs.

Figure 5: UCLA Hip and Knee Mean Scores Pre-Surgery and One Year Post-Surgery (N=15,188)

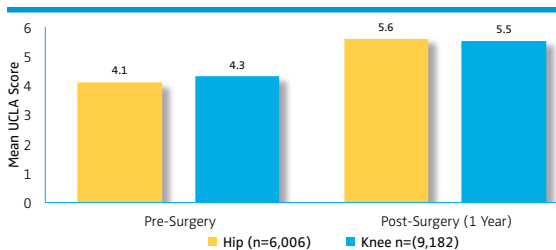


Table 5: Change in UCLA Score Pre-Surgery and One Year Post-Surgery, by Hospital*

Hospital Code	Count of Patients That Had Orthopedic Surgery, N	Count of Patients That Had Orthopedic Surgery and Completed a Survey about Their Physical Health before and after Surgery, N	Response Rate - Percentage of Patients Who Completed Pre-op and 1-Year UCLA Activity Score, %	Percent of Patients That Reported Meaningful Improvement in Their UCLA Activity Score after Surgery - Adjusted for Difference in Patient Health, %	Performance Rating
Overall	21,167	3,546	16.7		
Alta Bates Summit Medical Center - Bates Campus	327	92	28.1	58.2	★★★★★
Alta Bates Summit Medical Center - Summit Campus	428	103	24.1	50.5	★★★★★
California Pacific Medical Center	316	35	11.1	64.8	★★★★★
Cedars-Sinai Medical Center	879	115	13.1	64.5	★★★★★
Eisenhower Medical Center	1,091	422	38.7	43.4	★★★★★
Hoag Orthopedic Institute	7,205	616	8.5	71.2	★★★★★
John Muir Medical Center, Concord	808	91	11.3	62.1	★★★★★
John Muir Medical Center, Walnut Creek	1,569	192	12.2	59.4	★★★★★
Lodi Memorial Hospital	185	51	27.6	60.0	★★★★★
Long Beach Memorial	453	55	12.1	54.2	★★★★★
Memorial Medical Center	195	45	23.1	62.7	★★★★★
Methodist Hospital of Sacramento	369	96	26.0	71.8	★★★★★
Mills-Peninsula Medical Center	640	170	26.6	54.4	★★★★★
PIH Health Hospital - Whittier	942	75	8.0	62.9	★★★★★
Saddleback Memorial	776	77	9.9	60.4	★★★★★
Scripps Green Hospital	294	89	30.3	66.1	★★★★★
St. Joseph Hospital	381	111	29.1	66.0	★★★★★
St. Jude Medical Center	328	97	29.6	52.9	★★★★★
Stanford Healthcare	1,259	189	15.0	67.7	★★★★★
Tri-City Medical Center	339	113	33.3	58.9	★★★★★
UCSF Medical Center	1,231	620	50.4	65.2	★★★★★

*For hospitals with >30 eligible patients who completed both pre-surgical and 1 year post-surgical PROs.

Procedural Data Metrics

Figure 6: Cumulative Case Volume by Procedure Type (N=23,682)

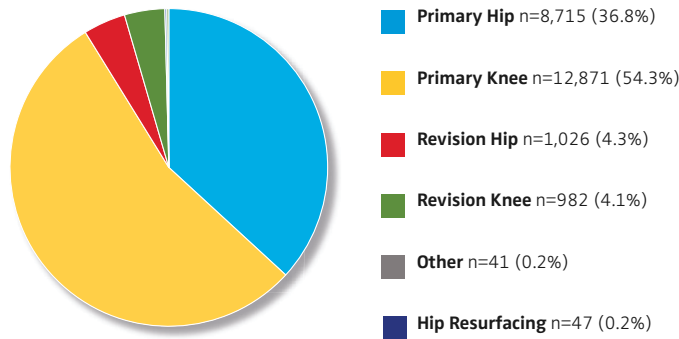
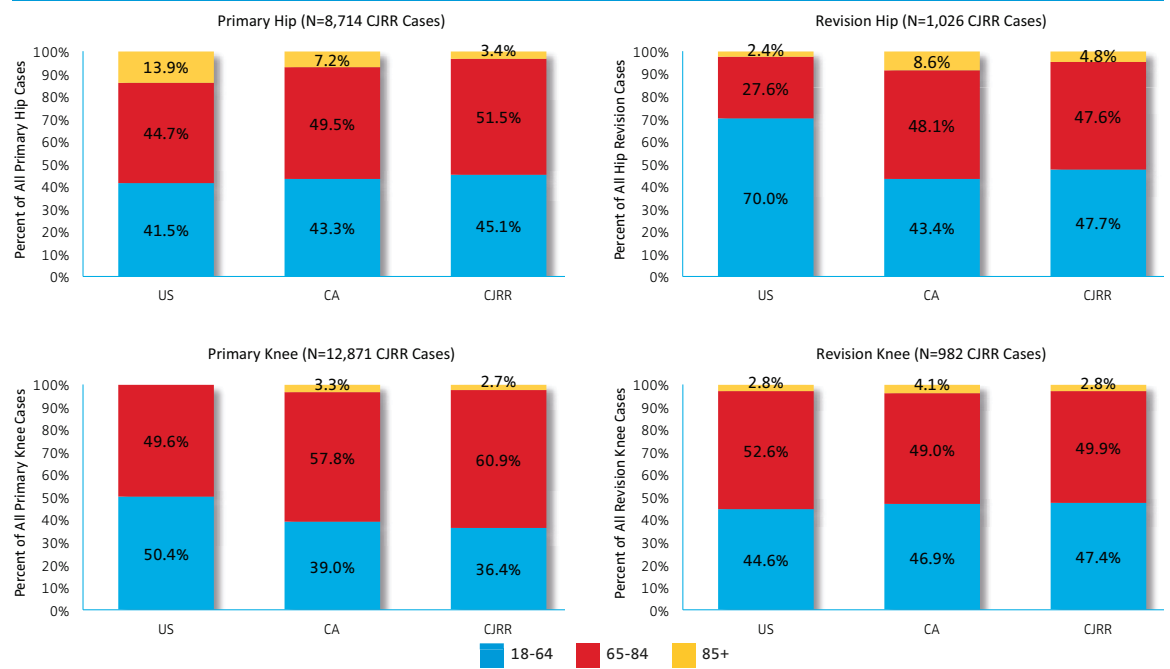


Figure 7: Age Distribution of Cases in CJRR, California, and United States, by Procedure



Source: Healthcare Cost and Utilization Project [HCUP], 2012 (US). State of California Office of Statewide Health Planning and Development [OSHPD], 2012 (California). CJRR, January 2011 to December 2015.

Figure 8: CJRR Cases by Procedure and Gender (N=23,681)

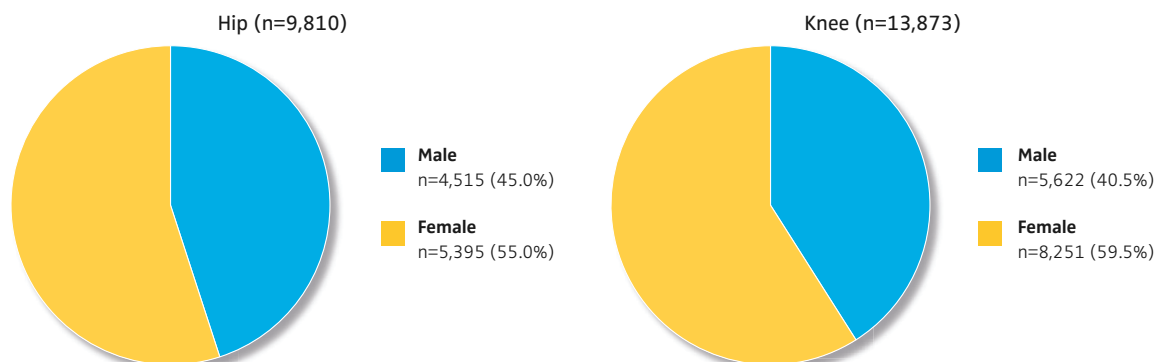


Figure 9: Mean Body Mass Index (BMI) by Procedure and Gender (N=23,594)

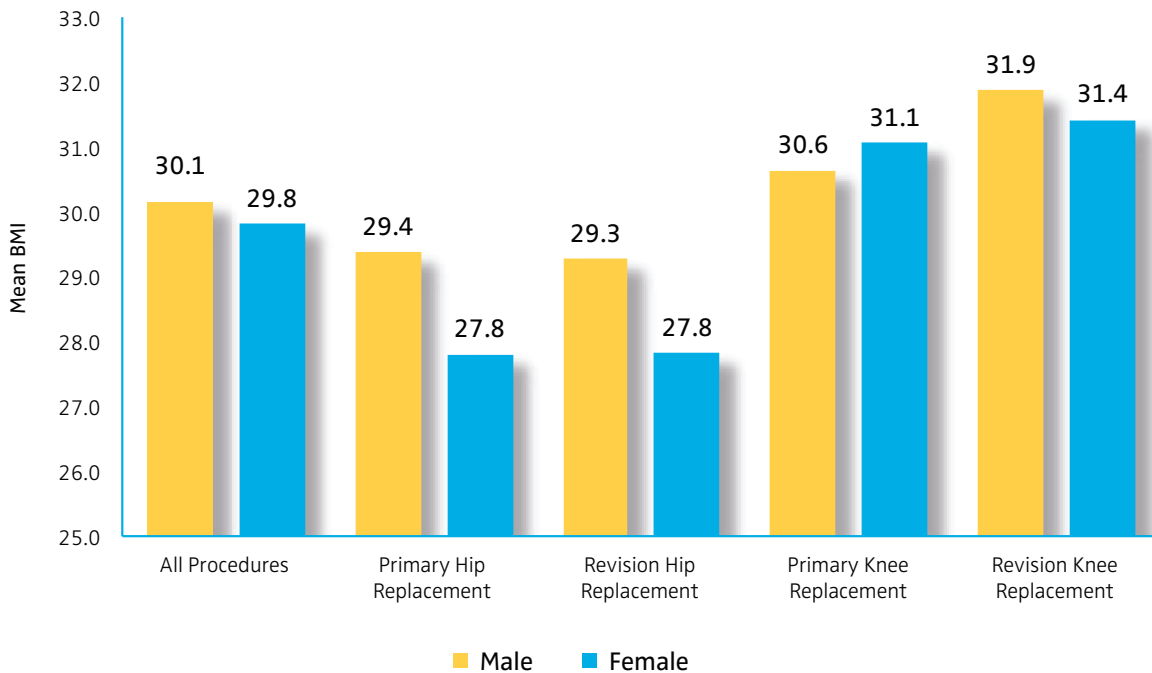


Figure 10: Principal Diagnoses (N=23,583)

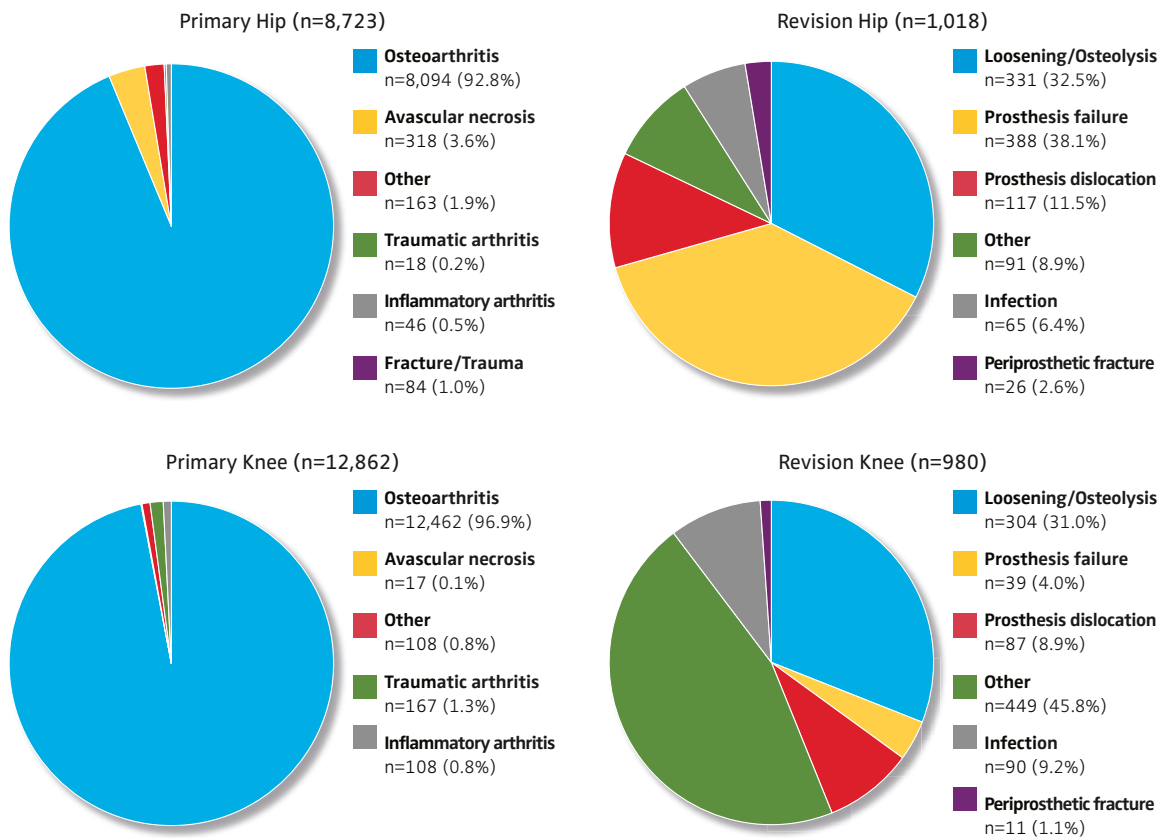


Table 6: Approach for Primary THA (N=1,730)

Approach	n	% of total cases recorded
Anterior	84	4.9
Direct Lateral	91	5.3
Posterior	1,555	89.8

Table 7: Femoral Head Size in Primary THA (N=8,571)

Diameter (mm)	n	%
22	23	0.3
26	1	0.01
28	274	3.2
30	1	0.01
32	1,901	22.2
34	20	0.2
36	5,649	65.9
38	132	1.5
40	532	6.2
42	2	0.02
43	1	0.01
44	32	0.4
47	1	0.01
54	1	0.01
55	1	0.01

Table 8: Femoral Head Size in Revision THA (N=992)

Diameter (mm)	n	%
22	10	1.0
26	1	0.1
28	124	12.5
32	151	15.2
36	500	50.4
38	9	0.9
40	178	17.9
42	2	0.2
44	15	1.5
49	1	0.1
61	1	0.1

Table 9: Bearing Couples in Primary THA (N=8,571)

Femoral Head Material	Acetabular Liner Material	% of Total Cases Recorded
Metal	Cross-linked Polyethylene	50.9
Ceramic	Cross-linked Polyethylene	47.8
Ceramic	Other Polyethylene	0.9
Ceramic	Ceramic	0.4
Metal	Metal	0.01
Ceramic	Metal	0.01

Table 10: Bearing Couples in Revision THA (N=992)

Femoral Head Material	Acetabular Liner Material	% of Total Cases Recorded
Metal	Cross-linked Polyethylene	67.2
Ceramic	Cross-linked Polyethylene	32.2
Ceramic	Ceramic	0.2

Table 11: Level of Constraint in Primary TKA (N=12,859)

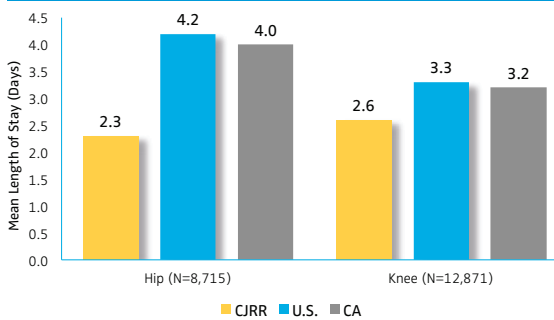
Level of Constraint	% of Total Cases Recorded
Cruciate Retaining	31.2
Posterior Substituting	63.9
Constrained Condylar	4.9
Hinged	0.3

Table 12: Level of Constraint in Revision TKA (N=978)

Level of Constraint	% of Total Cases Recorded
Cruciate Retaining	3.8
Posterior Substituting	28.0
Constrained Condylar	53.4
Hinged	14.8

Length of Stay

Figure 11: Mean Length of Stay (N=21,586)

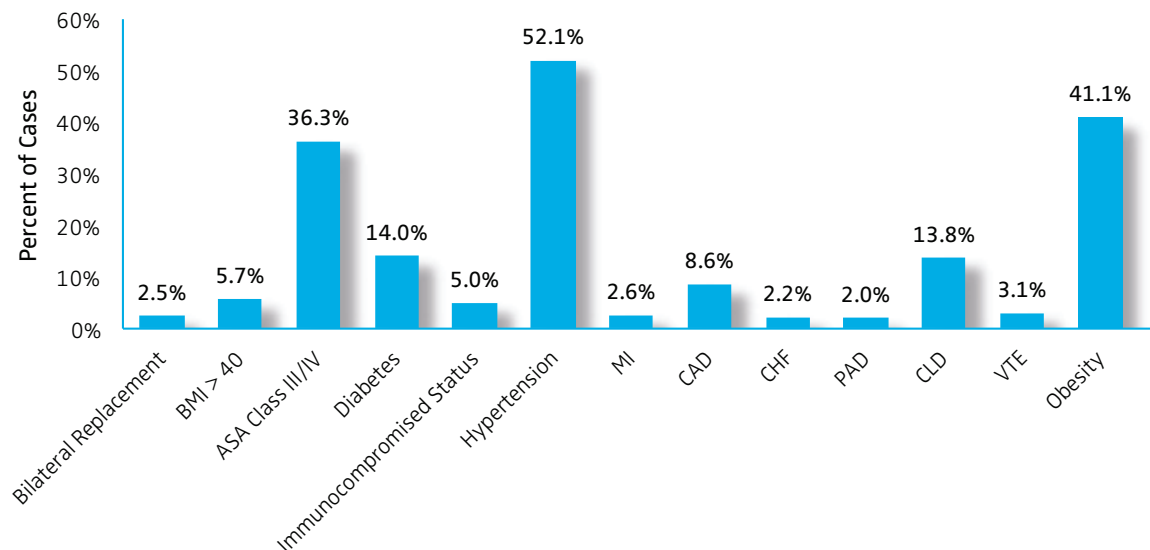


Comorbidities and Adverse Events

Figure 12: Observed Comorbidities (N=23,109)

CJRR observed these major conditions in its population of patients:

- Bilateral Replacement
- Body Mass Index (BMI) >40
- American Society of Anesthesiologists (ASA) Class III/IV
- Diabetes
- Immunocompromised status
- Hypertension
- Myocardial Infarction (MI)
- Coronary Artery Disease (CAD)
- Congestive Heart Failure (CHF)
- Peripheral Artery Disease (PAD)
- Chronic Lung Disease (CLD)
- Venous Thromboembolism (VTE)
- Obesity



Total hip arthroplasty represents approximately 80% of the hip procedures performed in this sample, with hemiarthroplasty and revision arthroplasty accounting for the bulk of the remainder at about 10% each. Hip resurfacing in the U.S. now accounts for less than 1% of the overall arthroplasties (Figure 13).

Figure 13: Observed 90-Day Adverse Events (N=23,690)

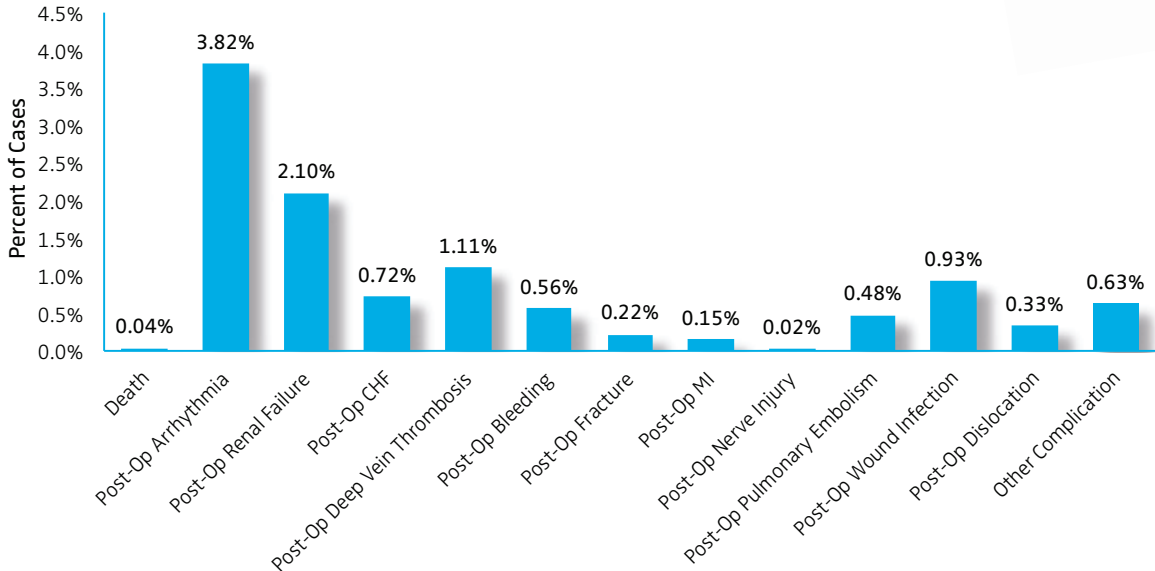
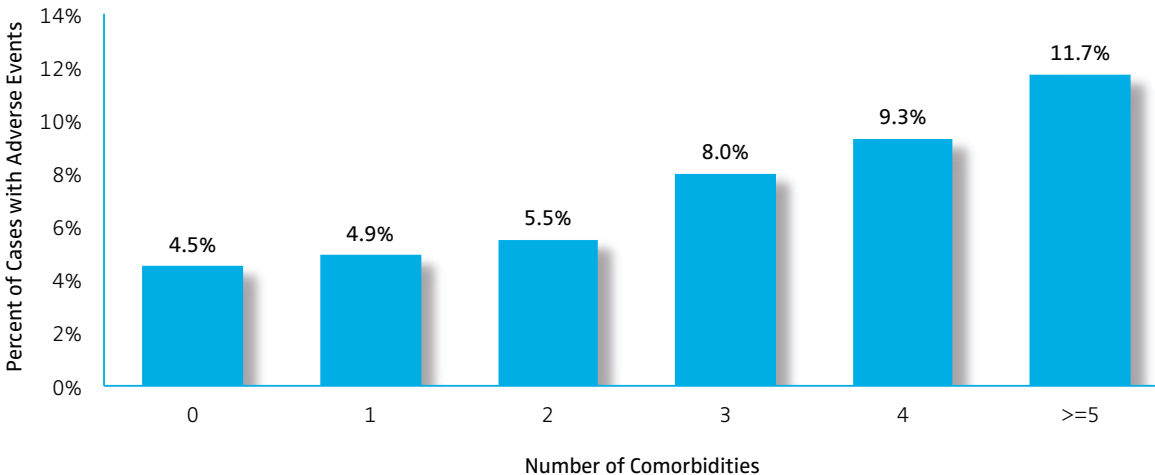


Figure 14: Rates of 90-Day Adverse Events, Number of Comorbidities (N=23,108)



Appendix A:

CJRR Methodology for Reporting Meaningful Change in Risk-Adjusted Patient-Reported Outcomes

Background

The California Joint Replacement Registry (CJRR) publicly reports risk-adjusted patient reported outcomes (PRO) for joint replacement surgeries in CJRR-participating hospitals. Risk-adjustment controls for diseases and conditions and other patient characteristics that vary from hospital to hospital and may cause PROs to vary because of circumstances outside of a provider's control.

Model Development

Patient Sample

Patients undergoing primary total hip or primary total knee replacement (unilateral or bilateral) were included in the risk adjustment modeling and subsequent public reporting. Patients with pathological fractures or malignant neoplasms (primary or metastatic cancer) were excluded. See Table 1 in the Appendix for a list of excluded codes. Cases are eligible if at least one year has elapsed since the procedure occurred. Cases are complete if the patient has finished a pre-procedure PRO survey and also a one-year post-procedure PRO survey. The hospital response rate is the number of complete cases divided by the number of eligible cases.

PRO Measure

CJRR collects PRO data using three distinct surveys: VR-12, Western Ontario and McMaster Universities Arthritis Index (WOMAC), and the UCLA Activity Index. From the data, the specific outcome measure to be reported is the percentage of respondents that had Minimal Clinically Important Differences between pre- and post- scores (MCID). Survey responses sometimes have statistically significant differences that are associated with small clinical changes. The MCID accounts for this, making sure that all patients who are counted as having positive post-procedure change have meaningful changes in their scores.

Risk Adjustment Methods

The risk-adjustment approach used in CJRR compares the 95% confidence interval of each hospital's risk-adjusted PRO MCID rate (RAR) to all participating hospitals' overall PRO MCID rate to identify hospital performance "Better" or "Worse" outliers. The risk-adjusted PRO results represent what a hospital's PRO MCID rate would have been if the hospital had a patient case mix identical to the reference population. For CJRR, the reference population is the patient population of all CJRR participating hospitals. A hospital's RACR is calculated by dividing the hospital's observed PRO MCID rate by the hospital's expected PRO MCID rate (obtained from the risk model calculation) to get the observed/expected (O/E) ratio. If the O/E ratio is greater than one, the hospital has a higher PRO MCID rate than expected given its patient mix. If the O/E ratio is less than one, the hospital has a lower PRO MCID rate than expected. The O/E ratio is then multiplied by the overall PRO MCID rate of all participating hospitals to obtain the hospital's risk-adjusted PRO MCID rate.

¹ Partial procedures, resurfacings, and revisions were excluded

² <http://www.womac.org/womac/index.htm>

³ Change in Score between Pre-Op and 1-year Post-Op \geq the Minimal Clinically Important Difference ($0.5 \times$ standard deviation of mean change in scores)

Statistical Analysis

All candidate risk factors were entered into a stepwise, backward-selection logistic regression model. Candidate risk factors included age, gender, race (Caucasian), ASA Class, ASA Class grouped, hip versus knee procedure, multiple simultaneous procedures, diabetes, immunocompromised status, obese, hypertension history, MI history, CAD History, CLD history, VTE history, count of risk factors, surgery year, and median household income. These variables were collected from patient records where available and reported by participating hospitals. Patients with missing data for these variables were assigned a value not associated with MCIDs. For example, a patient with missing BMI would be assigned an obese score of "No."

The variable selection method required an individual predictor to be associated with PRO MCID at the 0.05 level of significance to be retained. Predictor variables that did not meet this level of significance were dropped. A final risk model was specified by keeping all predictor variables that met the 0.05 level of significance in the automated selection method, and by adding additional variables that were not statistically significant but were clinically meaningful.

The CJRR Reporting Subcommittee determined that the resulting risk adjustment model had adequate fit (Hosmer-Lemesow lack-of-fit chi-square = 0.10-0.27), and that it was adequately predictive (c=0.70-0.86).

Final Risk Adjustment Variables

The final risk adjustment regression model included several patient-level variables known to be associated with improved patient-reported outcomes:

- Preoperative score
- Age: Patient age in years at the time of surgery
- Gender: Male / Female
- Race: Caucasian / Other
- ASA Physical Status Classification System score: (3 or 4) / (1 or 2)
- Obese: Body Mass Index (BMI) score of 30 greater
- Diabetes: Yes / No
- Hypertension History: Yes / No
- Chronic Lung Disease History: Yes / No
- Hip versus Knee Procedure

Calculation of Hospital Risk-Adjusted MCID Outcome

The risk-adjustment regression model was used to calculate expected MCIDs for each hospital using patient-level data. The expected PRO MCID rate was the number of expected MCIDs as predicted by the risk-adjustment model, divided by the total number of actual, eligible joint replacement surgery cases, multiplied by 100. The expected event rate is adjusted for the severity of the hospital's case mix. The observed PRO MCID rate was the number of observed MCIDs divided by the total number of eligible joint replacement surgery cases, multiplied by 100.

The risk-adjusted MCID rate (RAR) was obtained by multiplying the population observed MCID rate by the hospital's Observed / Expected ratio. The risk-adjusted event rate reflects the best estimate of what a provider's MCID rate would have been if the provider had a patient case mix identical to the overall CJRR average. This rate is comparable among providers because it accounts for the differences in patient severity-of-illness.

Each provider's performance rating was based on a comparison of the 95% confidence interval (CI) of each provider's RAR to the population average MCID rate. The Poisson exact probability method was used for computing the 95% CI for the RAR.

Exclusion Codes Used in CJRR PRO Measure

- 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 short bones of lower limb
- 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
- 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
- 733.8 Malunion and nonunion of fracture
- 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 specific part of pelvis
- 808.50 Open fracture of other specified part of pelvis
- 808.51 Open fracture of ilium
- 808.52 Open fracture of ischium
- 808.53 Multiple open fractures with disruption of pelvic circle
- 808.54 Multiple open fractures without disruption of pelvic circle
- 808.8 Unspecified closed fracture of pelvis
- 820 Fracture of neck of femur

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