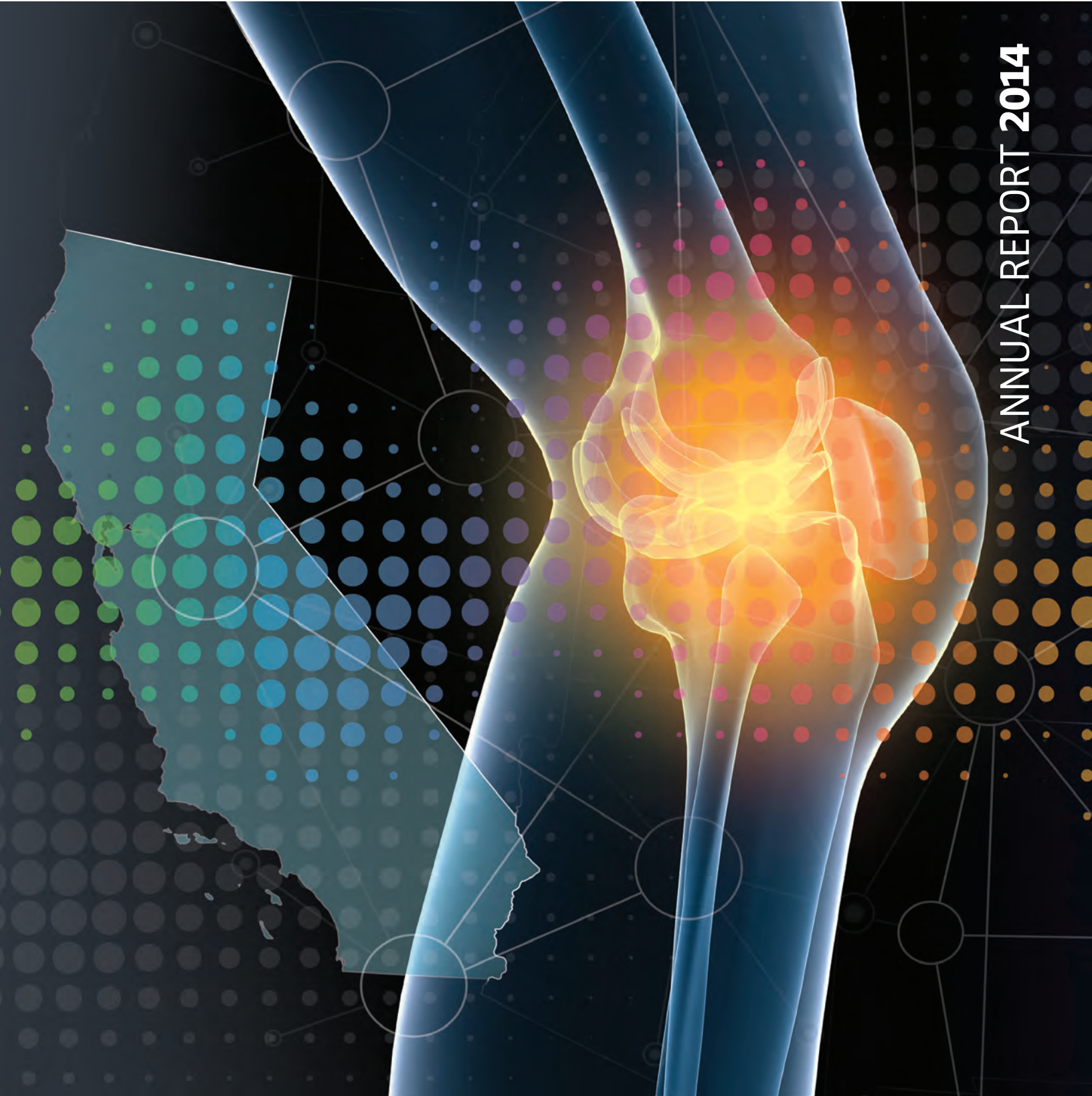




CALIFORNIA  
JOINT REPLACEMENT  
REGISTRY



ANNUAL REPORT 2014

# Dedication

We gratefully dedicate the 2014 Annual Report of the California Joint Replacement Registry to Kevin Bozic, MD, MBA. The CJRR is the product of Kevin's vision, leadership, passion, and commitment to optimizing the value of hip and knee replacement care in California and beyond.

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# Foreword

## From CJRR's Medical Director

The data presented in this *2014 Annual Report* of the California Joint Replacement Registry were collected between April 1, 2011 and May 20, 2015. Since the initial progress report was released in 2014, the volume of cases in CJRR has nearly doubled, while the volume of hospitals and surgeons that contribute cases has tripled. The data included in this report—on 8,130 knee replacements and 6,023 hip replacements—were submitted by 163 surgeons at 26 hospitals. Thirteen more hospitals are in the process of joining CJRR.

CJRR was created to meet the need for comprehensive, scientific assessment of devices, treatment protocols, surgical approaches, and patient factors that influence the outcomes of hip and knee replacement operations. Founded in 2009 by the California HealthCare Foundation (CHCF), the Pacific Business Group on Health (PBGH), and the California Orthopaedic Association (COA), the Registry was designed to serve as a resource for evidence-based comparative effectiveness by pooling and analyzing data from surgeons and hospitals across California. CJRR enables improved decision-making for patients, purchasers, physicians, hospitals, and other providers by gathering and promoting performance information on hip and knee replacements.

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 the country. Level III registries include patient-reported outcome (PRO) data as well as payer, provider, clinical, surgical, laboratory, pharmacy, and device information.

CJRR is supported by many large purchasers 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
- 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](http://www.castlighthouse.com), indicating that CJRR participants collect patient-reported outcomes and participate in the Registry

CJRR achieved two important objectives in 2015. The first was the release of hospital-level, risk-adjusted, patient-reported outcome scores in March 2015. The second was the announcement on April 1, 2015 that CJRR is now affiliated with the American Joint Replacement Registry (AJRR). Under the current agreement, AJRR has assumed responsibility for CJRR's operations during an 18-month

transition period. AJRR is anticipated to assume full responsibility for CJRR in 2018. Staffs from both CJRR and AJRR continue to collaborate in the recruitment of hospitals in California.

There are many people who deserve recognition for getting CJRR to this stage of development. For their vision and leadership, Kevin Bozic, David Lansky, Mark Smith, and Sandra Hernandez deserve thanks. Stephanie Teleki, Ernie Valente, Rachel Brodie, and Kate Eresian Chenok's contributions have been invaluable. I would like to acknowledge the current members of the California Data Use Group who continue to keep us on track: David Lewallen, Zhongmin Li, Jay Patel, Nelson SooHoo, Walter Sujansky, Stephanie Teleki, Margo Sims, Diane Przepiorski, and David Hopkins. I am grateful to the staff of the AJRR who carry on our mission by handling the day-to-day operations of CJRR. Finally, none of this would be possible without the dedication of the contributing surgeons and hospitals who embrace our mission of improving patient care and informing choices.

In this report, we have expanded on our previous reporting of risk-adjusted, patient-reported outcomes at the hospital level. Currently, all hospitals in CJRR that had sufficient longitudinal patient-reported survey data to report were graded as "average" for WOMAC, VR-12, and UCLA scores. We anticipate this will change as CJRR continues to grow. Improving data collection rates for all metrics remains an active area of investigation for CJRR. Despite developing a comprehensive risk-adjustment model for perioperative complications (Level II data), we have declined to report these data publicly as the model has not achieved acceptable statistical significance. In addition, re-admission and perioperative complications rates are reported publicly by other entities in contrast to our patient-reported outcome results, which have been more difficult for patients to access until now.

We remain engaged in several other exciting projects. We are prepared to address any data issues that arise with the transition to ICD-10. We continue our efforts to share certain data elements with Kaiser Permanente's National Implant Registries to collectively paint a broader view of the quality of hip and knee replacement care in California. Between CJRR and Kaiser, we would capture over 50% of hip and knee replacements performed annually in California. In an effort to improve awareness of our participating hospitals and surgeons, we have paired with the California Hospital Assessment and Ratings Task Force, who will publish CJRR hospital-level enrollment data on their website in the near future.

We are grateful to the many CJRR stakeholders who have worked together to make this effort a success. We hope you find the information in this report informative.

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 2014, the time period covered in this report, 26 hospitals and 163 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). Learn more at [www.ajrr.net/cjrr](http://www.ajrr.net/cjrr).

## Introduction

The health care landscape is changing. New tools are available for measuring health outcomes. There also is a rise in the public reporting of provider performance, and a strong focus on providing data on quality and value. While these data are becoming more readily available, there is still limited actionable data on outcomes associated with joint replacement surgery. CJRR is positioned to play a major role in making this information available to help surgeons and hospitals in California deliver better outcomes, patients to identify the highest quality providers, and payers to reward high-performing providers.

With more than 90,000 procedures performed and over \$8.1 billion in annual hospital and surgeon charges in California alone, hip and knee replacements are among the highest volume and highest cost surgeries for both Medicare and private payers. Moreover, the volume of joint replacements is expected to continue its rapid growth with a projected yearly rate of over four million procedures in the United States by 2030<sup>1</sup>. CJRR is providing critical information on quality and patient outcomes that will enable better decision-making by patients, purchasers, physicians, hospitals, and other providers, thereby improving the overall quality of care for these surgeries.

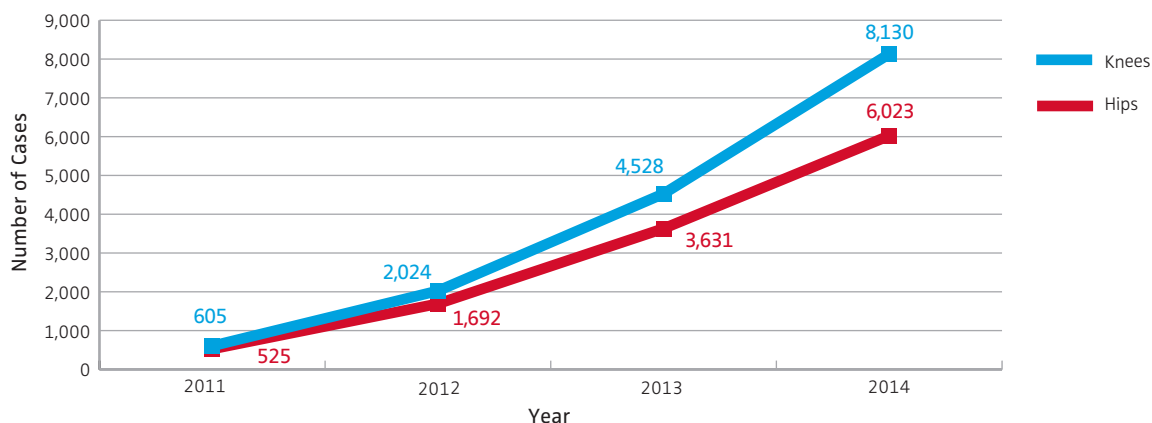
Research shows that hip and knee replacement procedures can successfully alleviate pain and improve function for patients who suffer from disabling arthritis of the hip and knee<sup>2</sup>. Despite these benefits, as volume and costs increase, there is a largely unmet need for continuous, comprehensive, scientific assessment of devices, treatment protocols, surgical approaches, and identification of patient factors influencing the outcomes of these surgeries.

# Overall Results

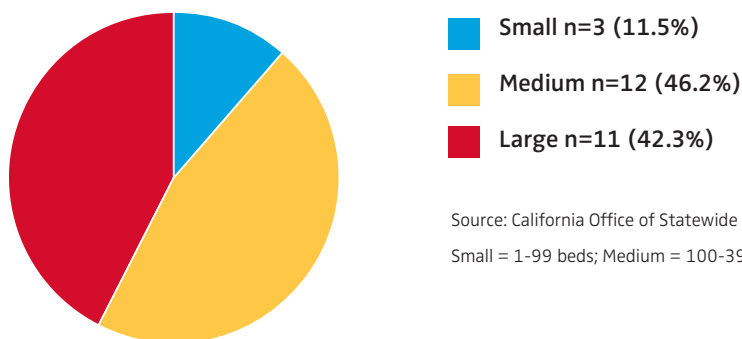
CJRR collects detailed case information from its registered patients, including approximately 140 data elements related to patient demographics, clinical and surgical data, and patient-reported outcomes (PROs). CJRR directly surveys patients about their pain and function before and at set intervals after their surgery. CJRR data are captured electronically from surgeons and hospitals and use ICD-9 codes, as well as other clinical information submitted by hospitals and physicians. These data include information on implants and surgical approach that will be used to identify potential patient safety issues and contribute to comparative effectiveness research.

CJRR now includes information from more than 14,000 cases (see Figure 1). CJRR is one of only a handful of registries in the United States that collects and reports feedback directly from patients concerning outcomes of their hip and knee replacement surgeries along with clinical and surgical data. As shown in Figure 2, CJRR hospital participants represent a range of sizes.

**Figure 1: Cumulative Case Volume (N=14,153)**



**Figure 2: CJRR Participants by Size (N=26)**



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

**Table 1: CJRR Participants and Cases Reported through August 2015**

Facility	Date Joined CJRR	Cases Reported
Alta Bates Summit Medical Center, Alta Bates Campus	9/17/12	299
Alta Bates Summit Medical Center, Summit Campus	9/17/12	338
California Pacific Medical Center	10/16/14	5
Cedars-Sinai Medical Center	5/9/11	762
Dameron Hospital	11/5/13	181
Dignity Health Methodist Hospital, Sacramento	3/18/14	184
Dignity Health St. Bernardine Medical Center	10/15/13	14
Eisenhower Medical Center	10/28/13	313
Hoag Orthopedic Institute	4/7/11	5,598
John Muir Medical Center, Concord	12/18/12	363
John Muir Medical Center, Walnut Creek	10/9/12	828
Lodi Memorial Hospital	3/10/14	87
Long Beach Memorial	10/6/14	74
Memorial Medical Center - Modesto	12/8/14	9
Mills-Peninsula Health Services	5/6/13	224
Novato Community Hospital	12/3/14	10
Orange Coast Memorial	9/23/14	80
PIH Health Hospital - Whittier	3/4/13	673
Saddleback Memorial - Laguna Hills	9/30/14	108
Scripps Green Hospital	8/19/13	163
St. Joseph Hospital (Orange, CA)	11/12/12	282
St. Jude Medical Center (Fullerton, CA)	8/12/13	244
Stanford Health Care	9/12/12	1,192
Sutter Medical Center, Sacramento	2/13/13	111
Tri-City Medical Center	4/15/14	117
University of California, San Francisco Medical Center	3/1/11	1,894

# Patient-Reported Outcomes

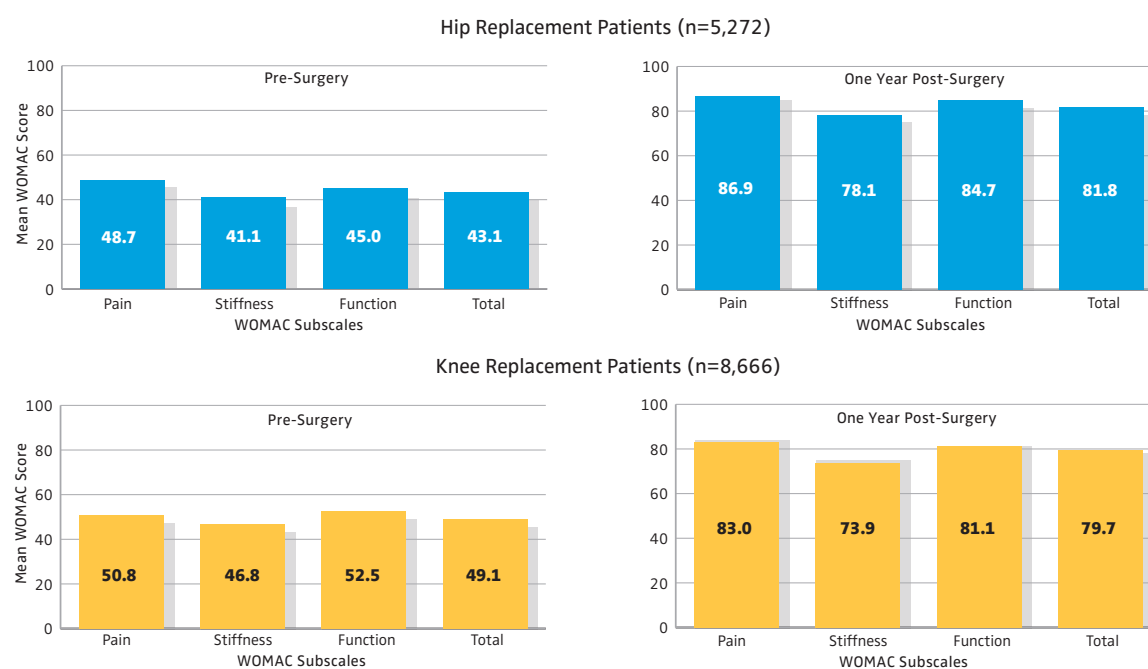
As mentioned earlier, CJRR collects information directly from patients, using several standardized surveys.

- The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), a 24-question survey, assesses a patient’s hip and knee pain, stiffness, 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 (physical and mental components scores) with 12 questions. As with the WOMAC, the VR-12 has a scale of 0 to 100, with 100 indicating the best health.
- 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.” This score is generated from a single question.

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 paper form, which 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. It’s estimated that it takes patients 15-30 minutes to answer these 37 questions in the three surveys. See CJRR Appendix A.

## PRO Results

**Figure 3: WOMAC Hip and Knee Mean Scores Pre-Surgery and One Year Post-Surgery (N=13,938)**

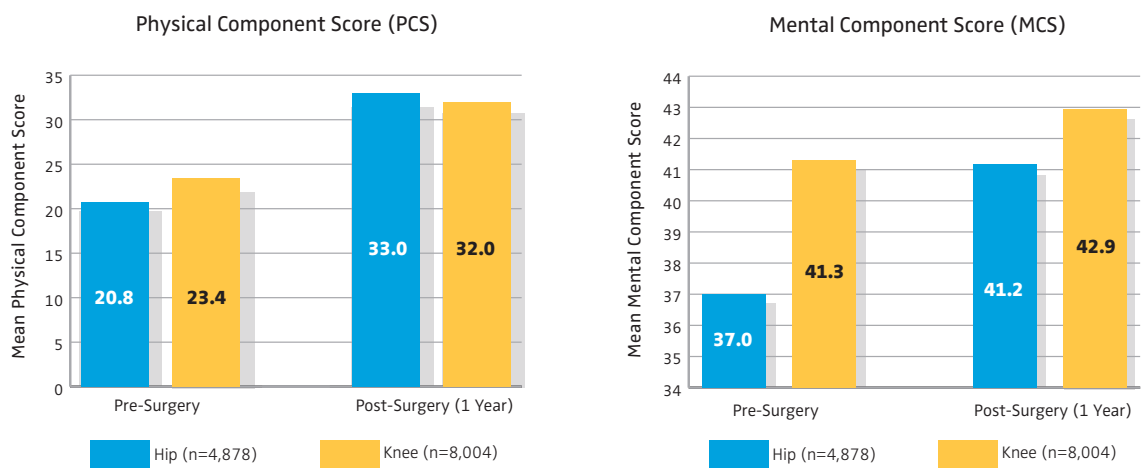


**Table 2: Change in WOMAC Score Pre-Surgery and One Year Post-Surgery, by Hospital\***

Hospital	Patients Who Had Surgery and Were Eligible to Take a Survey	Number of Eligible Patients Who Completed both Pre-op and 1-Year PRO, N (%)	Case Mix-Adjusted Percentage of Patients Who Reported Meaningful Improvement	Performance Rating
Alta Bates Summit Medical Center, Alta Bates Campus	217	69 (31.8%)	80.1%	★★★★★
Cedars-Sinai Medical Center	569	81 (14.2%)	83.5%	★★★★★
John Muir Medical Center, Concord	142	33 (23.2%)	92.8%	★★★★★
Eisenhower Medical Center	120	88 (73.3%)	95.4%	★★★★★
Hoag Orthopedic Institute	3,764	442 (11.7%)	89.0%	★★★★★
PIH Health Hospital - Whittier	346	49 (14.2%)	87.4%	★★★★★
St. Joseph Hospital (Orange, CA)	187	75 (40.1%)	88.9%	★★★★★
St. Jude Medical Center (Fullerton, CA)	166	40 (24.1%)	90.5%	★★★★★
Stanford Health Care	500	101 (20.2%)	88.0%	★★★★★
Alta Bates Summit Medical Center, Summit Campus	255	75 (29.4%)	87.0%	★★★★★
University of California, San Francisco Medical Center	999	576 (57.7%)	88.1%	★★★★★
John Muir Medical Center, Walnut Creek	325	53 (16.3%)	88.8%	★★★★★

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

**Figure 4: VR-12 Hip and Knee Mean Scores for Physical and Mental Component Scores, Pre-Surgery and One Year Post-Surgery (N=12,882)**





**Table 3: Change in VR-12 Physical and Mental Scores Pre-Surgery and One Year Post-Surgery by Hospital\*****Change in VR-12 Physical Score**

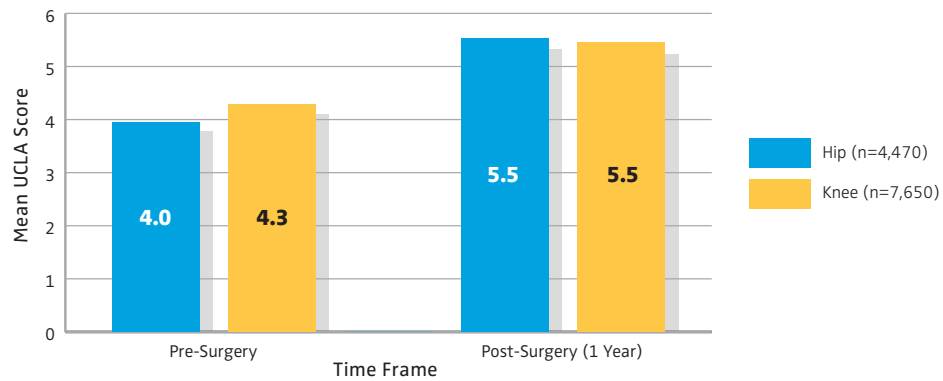
Hospital	Patients Who Had Surgery and Were Eligible to Take a Survey	Number of Eligible Patients Who Completed both Pre-op and 1-Year PRO, N (%)	Case Mix-Adjusted Percentage of Patients Who Reported Meaningful Improvement	Performance Rating
Alta Bates Summit Medical Center, Alta Bates Campus	217	75 (34.6%)	58.6%	★★★★★
Cedars-Sinai Medical Center	569	82 (14.4%)	72.2%	★★★★★
John Muir Medical Center, Concord	142	32 (22.5%)	80.8%	★★★★★
Eisenhower Medical Center	120	88 (73.3%)	80.5%	★★★★★
PIH Health Hospital - Whittier	346	50 (14.5%)	74.3%	★★★★★
St. Joseph Hospital (Orange, CA)	187	76 (40.6%)	74.3%	★★★★★
St. Jude Medical Center (Fullerton, CA)	166	44 (26.5%)	77.7%	★★★★★
Stanford Health Care	500	102 (20.4%)	69.9%	★★★★★
Alta Bates Summit Medical Center, Summit Campus	255	88 (34.5%)	72.1%	★★★★★
University of California, San Francisco Medical Center	999	587 (58.8%)	71.2%	★★★★★
John Muir Medical Center, Walnut Creek	325	54 (16.6%)	76.0%	★★★★★

**Change in VR-12 Mental Score**

Hospital	Patients Who Had Surgery and Were Eligible to Take a Survey	Number of Eligible Patients Who Completed both Pre-op and 1-Year PRO, N (%)	Case Mix-Adjusted Percentage of Patients Who Reported Meaningful Improvement	Performance Rating
Alta Bates Summit Medical Center, Alta Bates Campus	217	75 (34.6%)	30.4%	★★★★★
Cedars-Sinai Medical Center	569	82 (14.4%)	39.2%	★★★★★
John Muir Medical Center, Concord	142	32 (22.5%)	37.6%	★★★★★
Eisenhower Medical Center	120	88 (73.3%)	49.2%	★★★★★
PIH Health Hospital - Whittier	346	50 (14.5%)	36.2%	★★★★★
St. Joseph Hospital (Orange, CA)	187	76 (40.6%)	42.2%	★★★★★
St. Jude Medical Center (Fullerton, CA)	166	44 (26.5%)	43.7%	★★★★★
Stanford Health Care	500	102 (20.4%)	47.0%	★★★★★
Alta Bates Summit Medical Center, Summit Campus	255	88 (34.5%)	33.1%	★★★★★
University of California, San Francisco Medical Center	999	587 (58.8%)	36.9%	★★★★★
John Muir Medical Center, Walnut Creek	325	54 (16.6%)	36.9%	★★★★★

\*For hospitals with &gt;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=12,120)**



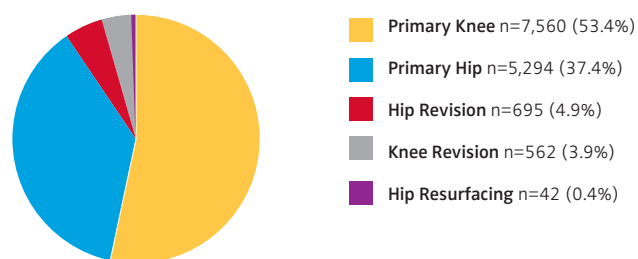
**Table 4: Change in UCLA Score Pre-Surgery and One Year Post-Surgery, by Hospital\***

Hospital	Patients Who Had Surgery and Were Eligible to Take a Survey	Number of Eligible Patients Who Completed both Pre-op and 1-Year PRO, N (%)	Case Mix-Adjusted Percentage of Patients Who Reported Meaningful Improvement	Performance Rating
Alta Bates Summit Medical Center, Alta Bates Campus	217	76 (35.0%)	61.1%	★★★★★
Cedars-Sinai Medical Center	569	77 (13.5%)	71.6%	★★★★★
John Muir Medical Center, Concord	142	31 (21.8%)	62.7%	★★★★★
Eisenhower Medical Center	120	88 (73.3%)	76.4%	★★★★★
Hoag Orthopedic Institute	3,764	429 (11.4%)	66.9%	★★★★★
PIH Health Hospital - Whittier	346	49 (14.2%)	71.2%	★★★★★
St. Joseph Hospital (Orange, CA)	187	73 (39.0%)	70.1%	★★★★★
St. Jude Medical Center (Fullerton, CA)	166	48 (28.9%)	52.5%	★★★★★
Stanford Health Care	500	99 (19.8%)	67.7%	★★★★★
Alta Bates Summit Medical Center, Summit Campus	255	89 (34.9%)	50.6%	★★★★★
University of California, San Francisco Medical Center	999	586 (58.7%)	64.8%	★★★★★
John Muir Medical Center, Walnut Creek	325	53 (16.3%)	60.5%	★★★★★

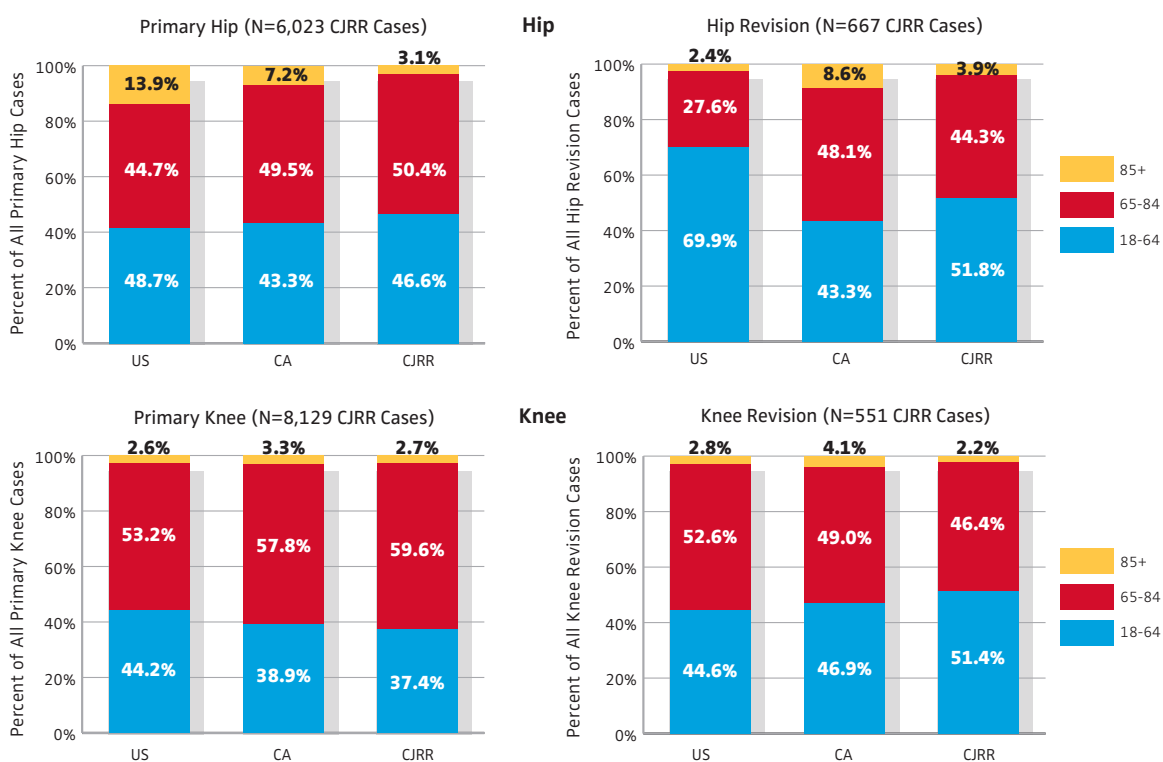
\*For hospitals with >30 eligible patients who completed both pre-surgical and 1 year post-surgical PROs.

# Procedural Data Metrics

**Figure 6: Cumulative Case Volume by Procedure Type (N= 14,153)**

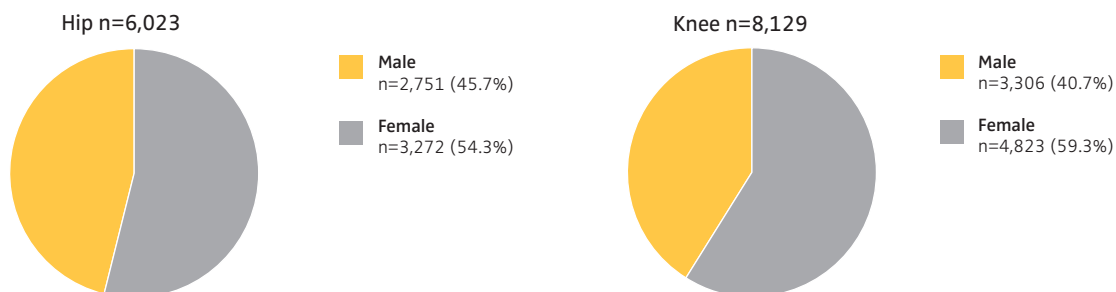


**Figure 7: Age Distribution of Cases in CJRR, California, and United States, by Procedure**

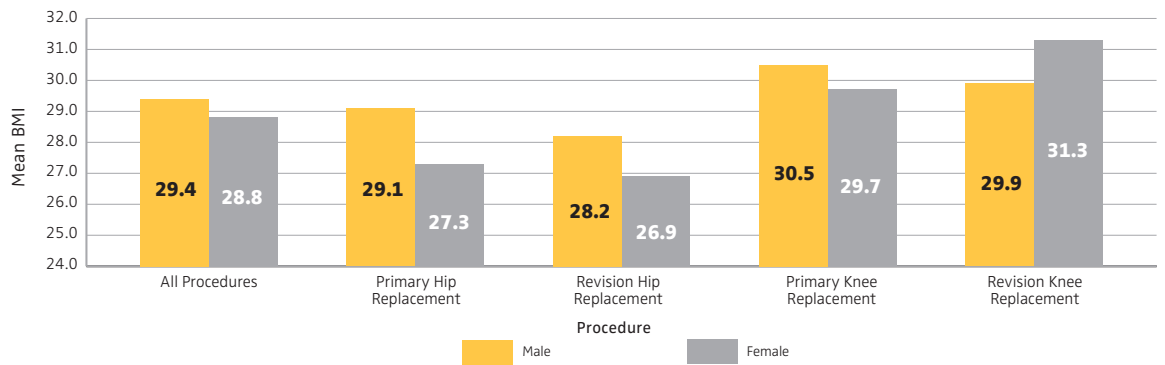


Source: Healthcare Cost and Utilization Project [HCUP], 2012 (US). State of California Office of Statewide Health Planning and Development [OSHPD], 2012 (California). CJRR, January 2011 to December 2014

**Figure 8: CJRR Cases by Procedure and Gender (N=14,152)**



**Figure 9: Mean Body Mass Index (BMI) by Procedure and Gender (N=14,152)**



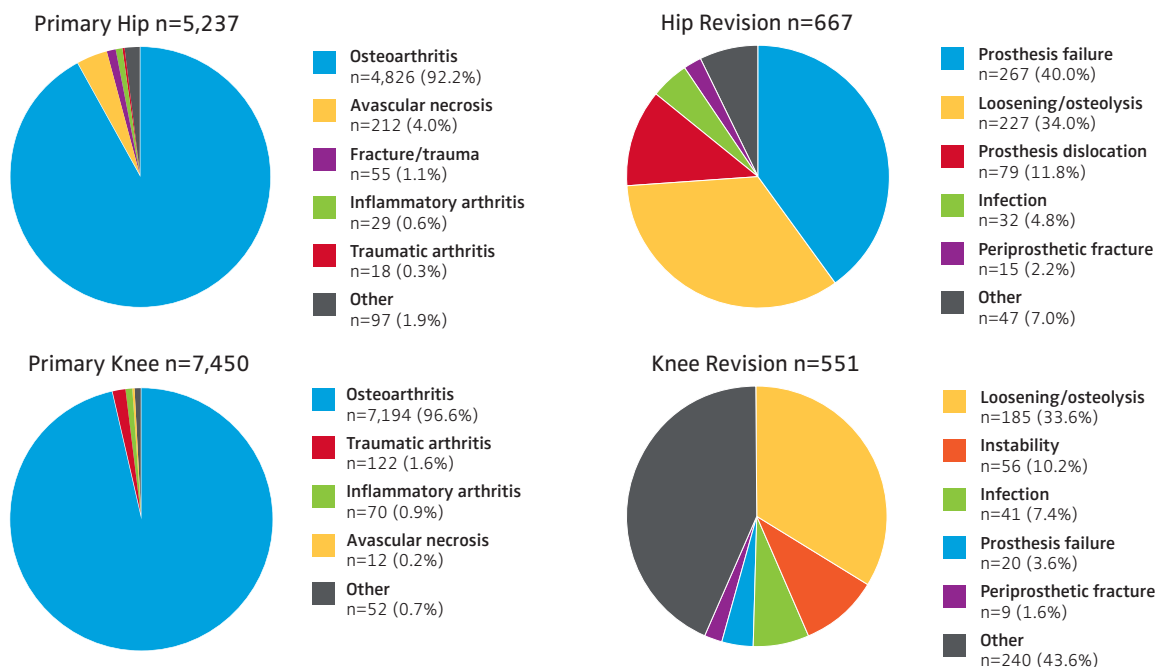
# Principal Diagnoses for Hip and Knee Replacements

Patients may require hip or knee replacements due to damage to the joints from a variety of causes. The most common diagnosis found in CJRR for hip and knee replacement is osteoarthritis (Figure 10). The major diagnosis categories for patients in CJRR are similar to national and international trends.

Unfortunately, many hip and knee replacements have to be revised (i.e. redone). Between 1990 and 2002, the mean hip revision rate of 17.5% and the mean knee revision rate of 8.2% remained stable in the United States<sup>1</sup>. In contrast, Sweden credits its registry programs for reducing the national hip revision rate to 7.5% and its knee revision rate to 6.4%<sup>3</sup>. In addition to the significant burden that a revision means to patients, such procedures are also very costly. Average hospital cost estimates for revision surgery range from \$19,000 to \$31,000<sup>4,5</sup>. Registries can be helpful in providing information on device failures and targeting areas for improvement.

The most common reasons for revision of total knee or total hip replacement are device loosening or failure, dislocation and instability, and infections (Figure 10).

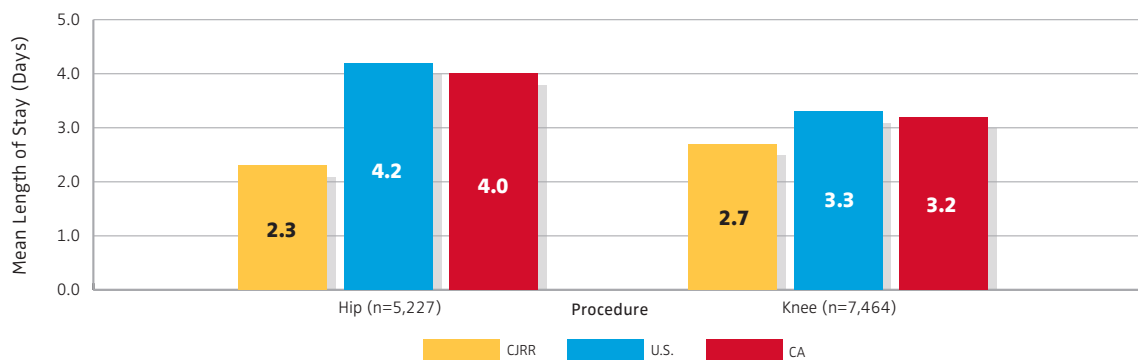
**Figure 10: Principal Diagnoses (N=13,905)**



# Length of Stay

Much of the cost related to a total joint replacement comes from the length of stay (LOS) in a hospital. As seen in Figure 11, CJRR hospitals have lower lengths of stay than California and U.S. hospitals.

**Figure 11: Mean Length of Stay (N=12,691)**



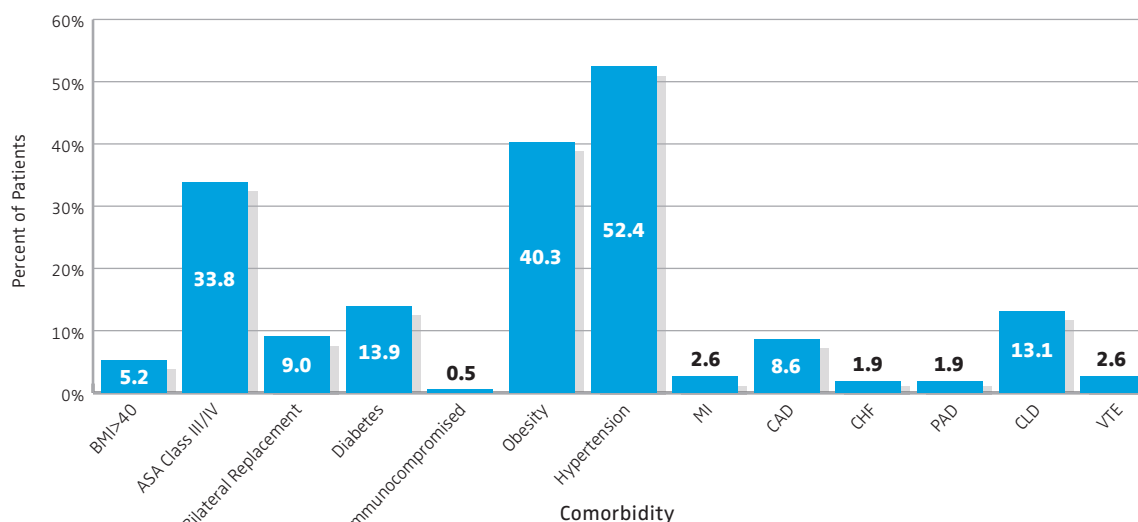
Source: HCUP, 2012 (US). OSHPD, 2012 (California). CJRR, January 2011 to December 2014

# Comorbidities and Adverse Events

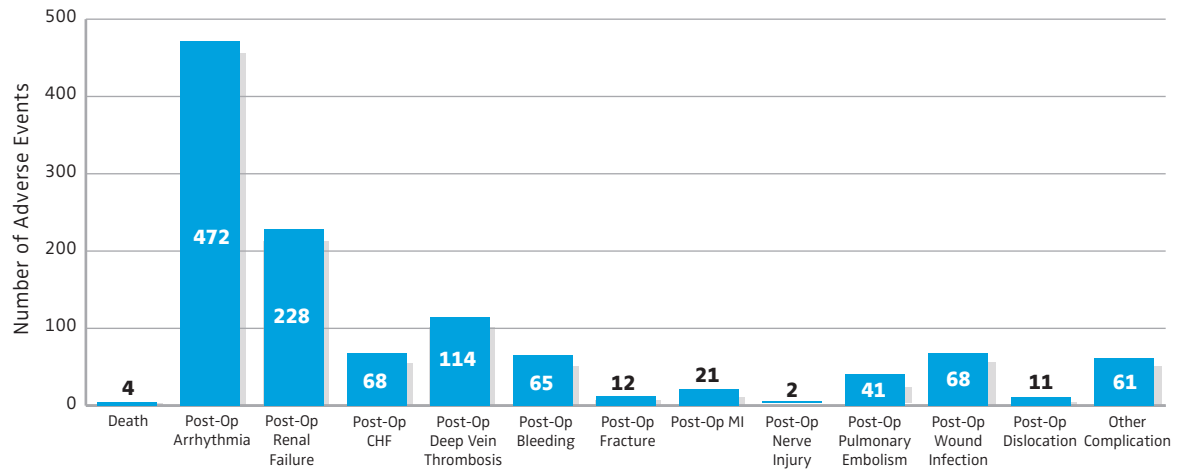
**Figure 12: Observed Comorbidities (N=13,433)**

CJRR observed these major conditions in its population of patients:

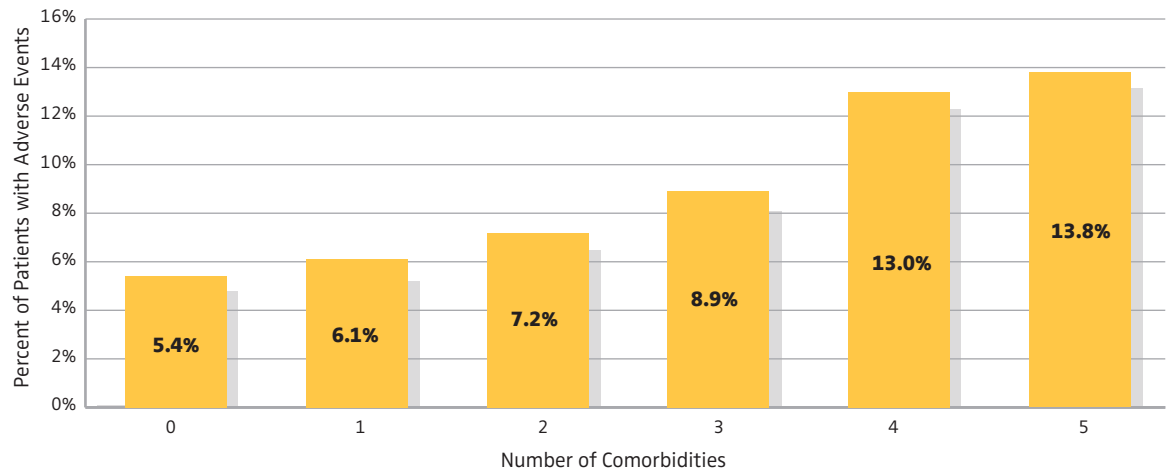
- Body Mass Index (BMI) >40
- American Society of Anesthesiologists (ASA) Class III/IV
- Bilateral Replacement
- Diabetes
- Immunocompromised status
- Obesity
- Hypertension
- Myocardial Infarction (MI)
- Coronary Artery Disease (CAD)
- Congestive Heart Failure (CHF)
- Peripheral Artery Disease (PAD)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



**Figure 13: Observed 90-Day Adverse Events (N=1,167)**



**Figure 14: Rates of 90-day Adverse Events, Number of Comorbidities (N=13,433)**



# CJRR Appendix A

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

*Risk-Adjustment for Patient-Reported Outcomes of Total Joint Replacement Surgeries California Joint Replacement Registry February 4, 2015*

### Background

The California Joint Replacement Registry (CJRR) plans to publicly report 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. These PRO results are based on data collected in CJRR about surgeries that occurred from April 1, 2011 through November 6, 2014. The calculations are current as of December 31, 2014.

### Model Development

#### Patient Sample

Patients undergoing primary total<sup>a</sup> 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 the accompanying list for excluded codes. A total of 5,780 eligible patients were registered by CJRR during the study period beginning April 1, 2011 through November 6, 2014, at 14 participating hospital sites. 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. There were 1,155 completed cases. The hospital response rate is the number of complete cases divided by the number of eligible cases. These PRO scores and performance outcome results are based on data collected in CJRR about surgeries that occurred from April 1, 2011 to November 6, 2014. The calculations are current as of December 31, 2014.

#### PRO Measure

CJRR collects PRO data using three distinct surveys: Veterans Rand 12-Item Health Survey (VR-12), Western Ontario and McMaster Universities Arthritis Index (WOMAC), and the UCLA Activity Index. The PRO measure that CJRR will report publicly at this time is the WOMAC, which is a condition-specific survey that asks patients about symptoms, pain, stiffness, and the patient's ability to perform various routine activities of daily life that are progressively more physically demanding<sup>b</sup>.

From the WOMAC data, the specific outcome measure to be reported is the percentage of WOMAC respondents that had Minimal Clinically Important Differences (MCID) between pre- and post- WOMAC scores<sup>c</sup>. 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 WOMAC scores.

### 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
733.1	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 specified 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 pelvic fractures with disruption of pelvic circle
808.54	Multiple open pelvic fractures without disruption of pelvic circle
808.8	Unspecified closed fracture of pelvis
820	Fracture of neck of femur
820.0	Transcervical fracture closed
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 femur closed
820.03	Fracture of base of neck of femur closed
820.09	Other transcervical fracture of femur closed
820.1	Transcervical fracture open
820.10	Fracture of unspecified intracapsular section of neck of femur open
820.11	Fracture of epiphysis (separation) (upper) of neck of femur open

### 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.

### 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 vs. 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-Lemeshow lack-of-fit chi-square = 0.299, n.s.), and that it was adequately predictive ( $c=0.78$ ).

### 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 WOMAC score
- Age: Patient age in years at the time of surgery
- Gender: Male / Female
- Race: Caucasian / Other
- ASA Physical Status Classification System score: (III/IV) / (I/II)
- Obese: Body Mass Index (BMI) score of 30 greater
- Diabetes: Yes / No
- Hypertension History: Yes / No
- Chronic Lung Disease History: Yes / No
- Hip vs. 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 (87.1%) 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 (87.1%). The Poisson exact probability method was used for computing the 95% CI for the RAR.

<sup>a</sup> Partial procedures, resurfacings, and revisions were excluded.

<sup>b</sup> <http://www.womac.org/womac/index.htm>

<sup>c</sup> Change in WOMAC Score between Pre-Op and 1-year Post-Op  $\geq$  the Minimal Clinically Important Difference (0.5\*standard deviation of mean change in scores).

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