

Shoulder Arthroplasty



AOA
AUSTRALIAN
ORTHOPAEDIC
ASSOCIATION



ANNUAL REPORT
2015

National Joint Replacement Registry

AUSTRALIAN ORTHOPAEDIC ASSOCIATION
NATIONAL JOINT REPLACEMENT REGISTRY

SHOULDER ARTHROPLASTY ANNUAL REPORT

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Procedures up to 31 December 2014

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INTRODUCTION

The 2015 Shoulder Arthroplasty Annual Report is based on the analysis of 27,236 shoulder procedures reported to the Registry with a procedure date up to and including 31 December 2014. This is an increase of 4,692 procedures compared to the 2014 Shoulder Arthroplasty Annual Report.

The Registry receives information from all hospitals (public and private) undertaking joint replacement. Currently there are 305 participating hospitals. This number varies from time to time due to hospital closures, new hospitals opening, or hospitals changing services. Of these, 281 have contributed shoulder replacement data.

National data collection on shoulder replacement commenced in November 2007, however the Registry had approval to collect shoulder arthroplasty procedures from a number of hospitals prior to the national start date. These data have also been included and therefore the data period for this report is 16 April 2004 to 31 December 2014.

Data Collection and Validation

The Registry approach to data collection, validation and outcome assessment for shoulder arthroplasty is identical to that used for hip and knee arthroplasty. A detailed description of this is available in the Introduction chapter of the Hip and Knee Arthroplasty Annual Report 2015, which is available on the website <https://aoanjrr.dmac.adelaide.edu.au/annual-reports-2015>.

Hospitals provide data on specific Registry forms, completed in theatre at the time of surgery and submitted to the Registry monthly. Shoulder procedures are reported using the 'Multi-Joint Form'. This form, as well as data forms for other joint replacement procedures, are available on the Registry website <https://aoanjrr.dmac.adelaide.edu.au/data-collection>.

Outcome Assessment

The Registry has reported the revisions per 100 observed component years. This statistic provides a good estimate of the rate of revision, however, it does not allow for changes in the rate of revision over time.

The Registry describes the time to first revision using the Kaplan-Meier estimates of survivorship. The cumulative percent revision at a certain time, for example five years, is the complement (in probability) of the Kaplan-Meier survivorship function at that time, multiplied by 100. The cumulative percent revision

accounts for right censoring due to death and 'closure' of the database at the time of analysis.

Mortality information is obtained by matching all procedures with the National Death Index (NDI) biannually. The NDI is the national mortality database maintained by the Australian Institute of Health and Welfare (AIHW). Access to the data required approval of a formal ethics application to AIHW.

Confidence intervals for the cumulative percent revision are unadjusted point-wise Greenwood estimates and should not be used to infer significant differences in revision between groups. Reported hazard ratios should be used when judging statistical significance.

Hazard ratios (HR) from Cox proportional hazards models, adjusting for age and gender where appropriate, are used to compare revision rates. For each model the assumption of proportional hazards is checked analytically. If the interaction between the predictor and the log of time is statistically significant in the standard Cox model, then a time varying model is estimated. Time points are iteratively chosen until the assumption of proportionality is met, and then the hazard ratios are calculated for each selected time period. If no time period is specified then the hazard ratio is over the entire follow up period. All tests are two-tailed at the 5% level of significance.

The cumulative percent revision (CPR) is displayed until the number at risk for the group reaches 40, unless the initial number for the group is less than 100, in which case the CPRs are reported until 10% of the initial number at risk remains. This avoids uninformative, imprecise estimates at the right tail of the distribution where the number at risk is low. Analytical comparisons of revision rates using the proportional hazards model are based on all available data¹.

In the presence of a competing risk for revision, the Kaplan-Meier method is known to overestimate the true probability of revision. Death of the patient before revision presents such a competing risk. In circumstances where the risk of death is high the bias in the Kaplan-Meier estimates may be substantial and the reported cumulative percent revision should be interpreted with caution.

The Registry is currently investigating the introduction of different analytic methods to cope with competing risks. Cumulative incidence is one method of estimating

¹ Pocock SJ, Clayton TC, Altman DG. *Survival plots of time to event outcomes in clinical trials: good practice and pitfalls*, Lancet 2002; 359: 1686-89.

the probability of revision in the presence of competing risks. Revision diagnosis cumulative incidence graphs deal with the competing risks of reasons for revision, highlighting the differences between groups in the pattern of revision over time. They also provide important insight into different mechanisms of failure.

More detailed information on the statistical methods used in this report is presented in Appendix 1.

An important Registry focus has been the continued development of a standardised algorithm to identify prostheses or combination of prostheses not performing to the level of others in the same class. The Registry refers to this group as 'prostheses with a higher than anticipated rate of revision'. A three-stage approach has been developed and is outlined in detail in the relevant section of the report.

Report Review Prior to Publication

In recent years, members of the Shoulder and Elbow Society of Australia have had the opportunity to review, comment and provide advice and feedback on the Annual Report prior to its publication. This year the review workshop was held in Adelaide on the 15 August 2015. Six orthopaedic surgeons from the Shoulder and Elbow Society attended the workshop, as well as the AOANJRR Director, Deputy Director and Registry and DMAC staff. All sections of the report related to the analysis of Registry data were reviewed.

Acknowledgements

The Registry is funded by the Commonwealth Government and continues to receive support and invaluable assistance from the Commonwealth Department of Health, State and Territory Health Departments and Orthopaedic Companies. The Registry could not function without the cooperation of a large number of organisations and individuals.

The Registry acknowledges the cooperation and support provided by those undertaking the surgery and completing the data forms, in particular all orthopaedic surgeons, registrars and nursing staff.

The Registry would also like to acknowledge the ongoing support of all hospitals both public and private that undertake arthroplasty surgery nationally. The support provided by each hospital through their nominated coordinator(s) is appreciated.

SHOULDER REPLACEMENT

Categories of Shoulder Replacement

The Registry groups shoulder replacement into three broad categories, primary partial, primary total and revision shoulder replacement.

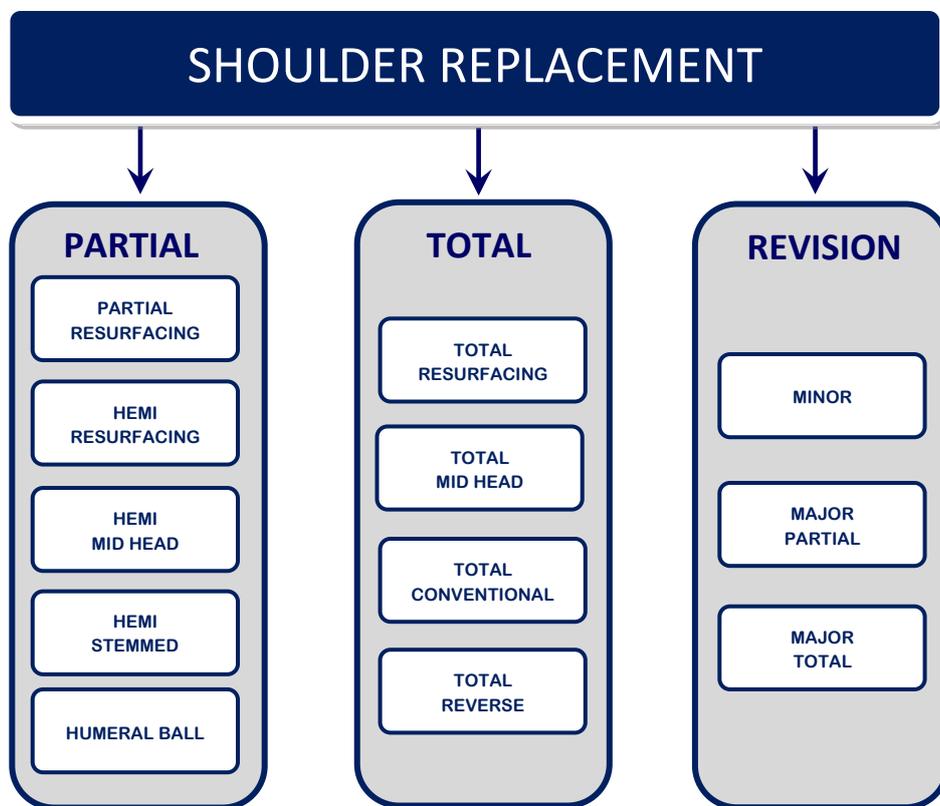
A primary replacement is the initial replacement procedure undertaken on a joint and involves replacing either part (partial) or all (total) of the articular surface.

Primary partial and primary total shoulder replacements are further sub-categorised into classes depending on the type of prostheses used. Partial shoulder classes are partial resurfacing, hemi resurfacing, hemi mid head, hemi stemmed and humeral ball replacement.

Total shoulder classes are total resurfacing, total mid head, total conventional and total reverse shoulder replacement. Definitions for each of these are detailed in the relevant chapters.

Revision procedures are re-operations of previous shoulder replacements where one or more of the prosthetic components are replaced, removed, or another component is added. Revisions include re-operations of primary partial, primary total or previous revision procedures.

Shoulder revisions are sub-categorised into three classes, minor, major partial and major total revisions.



Use of Shoulder Replacement

This Report is an analysis of 27,236 shoulder replacement procedures reported to the Registry with a procedure date up to and including 31 December 2014. This is an additional 4,692 shoulder procedures compared to the number reported last year. The first year that the Registry collected full national data on shoulder replacement was in 2008. The number of procedures in 2014 has increased by 6.0% compared to 2013 and 70.9% since 2008.

Shoulder replacement is more commonly undertaken in females (62.7%), with the majority between the ages of 65 and 84 years. The median age is 74 years for females and 70 years for males (Table S1 - Table S3 and Figure S1).

The Registry has recorded 2,024 bilateral shoulder replacements, 3.9% of which are performed within three

months of the initial procedure and 11.0% between three and six months (Table S4).

Most procedures are undertaken in private hospitals (69.0%) (Figure S2).

Of all shoulder procedures, total shoulder replacement is the most common. The proportion of total shoulder replacement has increased from 57.5% in 2008 to 80.9% in 2014. Between 2008 and 2014, partial shoulder replacement has decreased from 32.6% to 9.2%. The proportion of revision procedures increased from 9.9% in 2008 to 10.8% in 2012 and has decreased to 9.9% in 2014 (Figure S3).

Table S1 Number of Shoulder Replacements by Gender

Shoulder Replacement	Female		Male		TOTAL	
	N	%	N	%	N	%
Partial Resurfacing	30	23.3	99	76.7	129	2.4
Hemi Resurfacing	542	44.5	675	55.5	1217	22.5
Hemi Stemmed	3006	74.3	1042	25.7	4048	74.8
Hemi Mid Head	11	52.4	10	47.6	21	0.4
Primary Partial	3589	66.3	1826	33.7	5415	100.0
Total Resurfacing	69	38.1	112	61.9	181	0.9
Total Conventional	5249	58.9	3657	41.1	8906	46.7
Total Reverse	6411	66.2	3271	33.8	9682	50.8
Total Mid Head	166	57.2	124	42.8	290	1.5
Primary Total	11895	62.4	7164	37.6	19059	100.0
Revision	1602	58.0	1159	42.0	2761	100.0
TOTAL	17086	62.7	10149	37.3	27235	100.0

Note: Excludes one humeral ball procedure.

Table S2 Number of Shoulder Replacements by Age

Shoulder Replacement	<55		55-64		65-74		75-84		≥85		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
Partial Resurfacing	87	67.4	11	8.5	15	11.6	13	10.1	3	2.3	129	2.4
Hemi Resurfacing	224	18.4	337	27.7	382	31.4	227	18.7	47	3.9	1217	22.5
Hemi Stemmed	342	8.4	756	18.7	1224	30.2	1278	31.6	448	11.1	4048	74.8
Hemi Mid Head	5	23.8	4	19.0	8	38.1	3	14.3	1	4.8	21	0.4
Primary Partial	658	12.2	1108	20.5	1629	30.1	1521	28.1	499	9.2	5415	100.0
Total Resurfacing	29	16.0	61	33.7	75	41.4	15	8.3	1	0.6	181	0.9
Total Conventional	440	4.9	1942	21.8	3850	43.2	2414	27.1	260	2.9	8906	46.7
Total Reverse	127	1.3	750	7.7	3306	34.1	4454	46.0	1045	10.8	9682	50.8
Total Mid Head	16	5.5	67	23.1	130	44.8	71	24.5	6	2.1	290	1.5
Primary Total	612	3.2	2820	14.8	7361	38.6	6954	36.5	1312	6.9	19059	100.0
Revision	227	8.2	557	20.2	1009	36.5	785	28.4	183	6.6	2761	100.0
TOTAL	1497	5.5	4485	16.5	9999	36.7	9260	34.0	1994	7.3	27235	100.0

Note: Excludes one humeral ball procedure.

Table S3 All Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	17086	62.7%	13	102	74	73.1	9.4
Male	10150	37.3%	14	96	70	68.6	10.7
	27236	100.0%	13	102	72	71.4	10.1

Figure S1 All Shoulder by Age and Gender

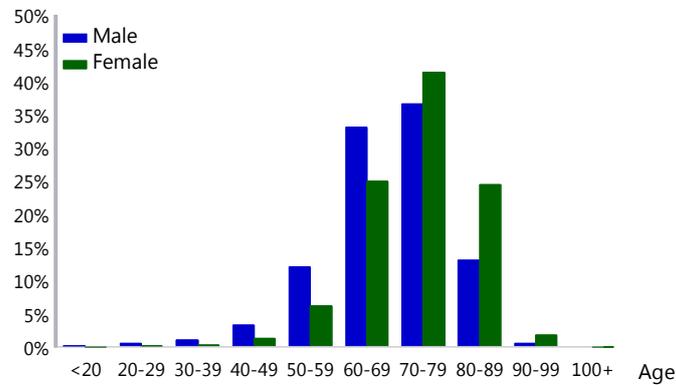


Table S4 Time between Procedures for Bilateral Primary Shoulder Replacement

Bilateral Procedures	<3 months		3months-6months		≥6months		TOTAL	
	N	Total%	N	Total%	N	Total%	N	Total%
Both Partial	27	1.3	16	0.8	110	5.4	153	7.6
Both Total	50	2.5	196	9.7	1464	72.3	1710	84.5
Total/Partial	2	0.1	11	0.5	148	7.3	161	8.0
TOTAL	79	3.9	223	11.0	1722	85.1	2024	100.0

Figure S2 Shoulder Replacements by Hospital Sector

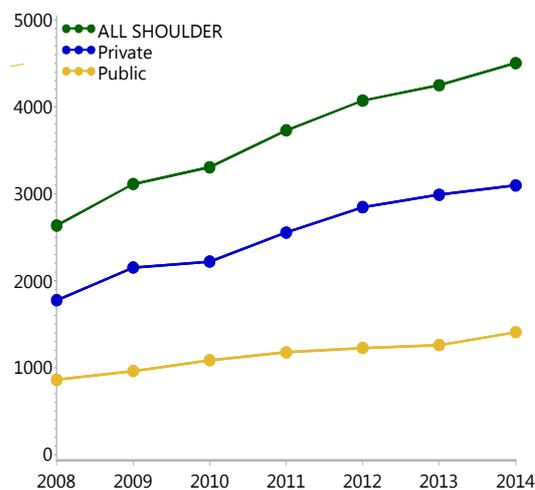
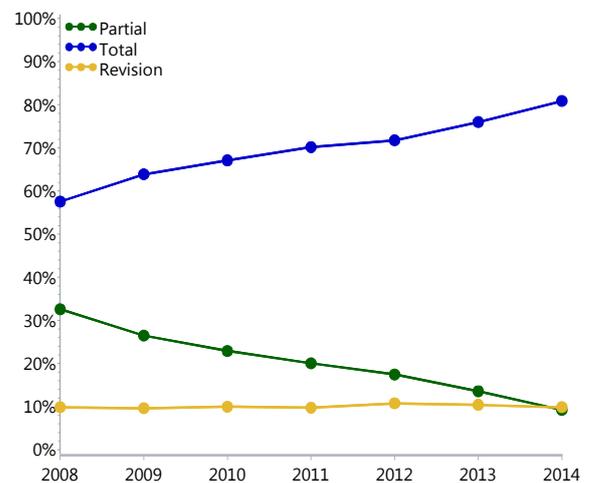


Figure S3 Proportion of Shoulder Replacements by Shoulder Category



PRIMARY PARTIAL SHOULDER REPLACEMENT

Classes of Partial Shoulder Replacement

The Registry sub-categorises primary partial shoulder replacement into four classes. These are defined as:

1. **Partial resurfacing** involves the use of one or more button prostheses to replace part of the natural articulating surface on one or both sides of the shoulder joint.
2. **Hemi resurfacing** includes the use of a humeral prosthesis that replaces the humeral articular surface only without resecting the head.
3. **Hemi mid head** includes resection of part of the humeral head and replacement with a cone stemmed humeral head prosthesis.
4. **Hemi stemmed** includes the resection of the humeral head and replacement with a stemmed humeral prosthesis and humeral head prosthesis.
5. **Humeral Ball** includes the resection of part of the humeral head and replacement with a spherical non-stemmed humeral head prosthesis.

This year, humeral ball replacement is included for the first time, however only one procedure has been recorded.

Primary partial shoulder replacement is more common in females (66.3%) with a median age of 73 years for females and 64 years for males. Fracture is the principal diagnosis (45.5%), followed by osteoarthritis (39.4%) (Table SP1, Table SP2 and Figure SP1).

The most common class of primary partial shoulder replacement is hemi stemmed. This accounts for 74.8% of all partial shoulder replacement (Table S1). The number of hemi resurfacing procedures declined from 178 in 2012 to 59 in 2014. In the same period hemi stemmed procedures declined from 519 to 348 (Figure SP2).

Of the 129 partial resurfacing procedures reported to the Registry, three have been revised. The seven year cumulative percent revision of hemi resurfacing is 13.9% and hemi stemmed replacement is 8.1%. Hemi resurfacing has a lower rate of revision than hemi stemmed replacement in the first year, however after two years the rate of revision of hemi resurfacing is higher than hemi stemmed. Primary hemi mid head prostheses have only been used in 21 procedures, one of which has been revised (Table SP3, Table SP4 and Figure SP3).

Use of Partial Shoulder Replacement

There have been 5,416 primary partial shoulder replacements reported to the Registry. This accounts for 19.9% of all shoulder replacement. There have been 460 additional primary partial shoulder replacements compared to the previous report.

Table SP1 Primary Partial Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	3589	66.3%	13	101	73	72.1	11.0
Male	1827	33.7%	14	93	64	63.1	14.1
TOTAL	5416	100.0%	13	101	70	69.0	12.9

Note: Includes one humeral ball procedure

Figure SP1 Primary Partial Shoulder Replacement by Age and Gender

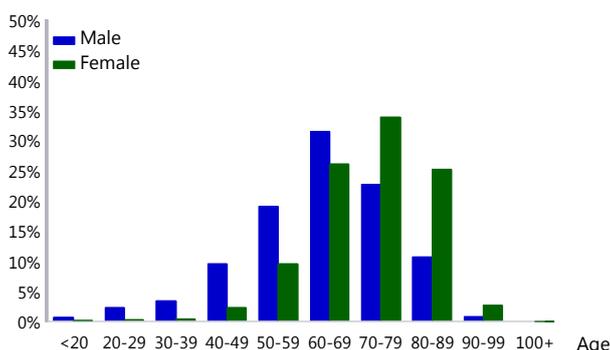


Table SP2 Primary Partial Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Fracture	511	28.0	1954	54.4	2465	45.5
Osteoarthritis	985	53.9	1150	32.0	2135	39.4
Rotator Cuff Arthropathy	103	5.6	153	4.3	256	4.7
Osteonecrosis	57	3.1	94	2.6	151	2.8
Dislocation	54	3.0	85	2.4	139	2.6
Rheumatoid Arthritis	14	0.8	83	2.3	97	1.8
Tumour	51	2.8	46	1.3	97	1.8
Instability	30	1.6	8	0.2	38	0.7
Other Inflammatory Arthritis	9	0.5	11	0.3	20	0.4
Hill-Sachs Defect	11	0.6	3	0.1	14	0.3
Osteochondritis Dissecans	2	0.1	.	.	2	0.0
Other	.	.	2	0.1	2	0.0
TOTAL	1827	100.0	3589	100.0	5416	100.0

Note: Includes one humeral ball procedure

Figure SP2 Partial Shoulder Replacement by Shoulder Class

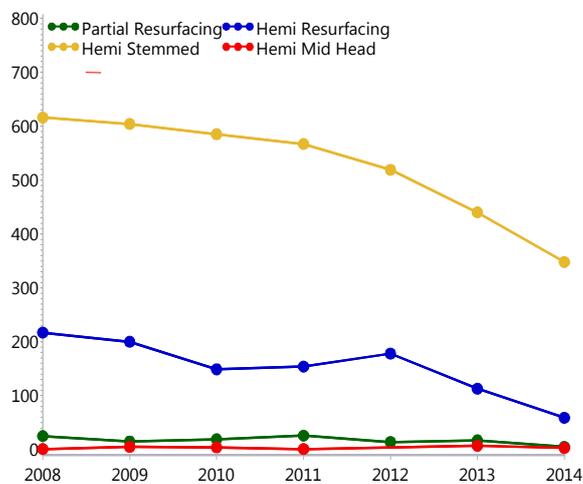


Table SP3 Revision Rates of Primary Partial Shoulder Replacement by Shoulder Class

Shoulder Class	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Partial Resurfacing	3	129	531	0.57 (0.12, 1.65)
Hemi Resurfacing	114	1217	4972	2.29 (1.89, 2.75)
Hemi Mid Head	1	21	61	1.64 (0.04, 9.15)
Hemi Stemmed	253	4048	14223	1.78 (1.57, 2.01)
TOTAL	371	5415	19787	1.87 (1.69, 2.08)

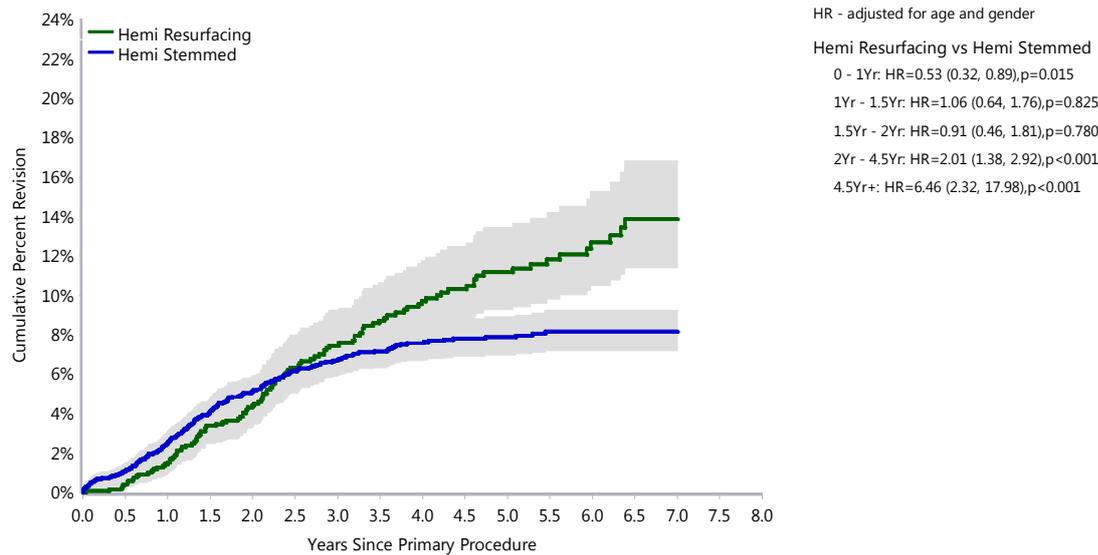
Note: Excludes one humeral ball procedure

Table SP4 Yearly Cumulative Percent Revision of Primary Partial Shoulder Replacement by Shoulder Class

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Partial Resurfacing	0.8 (0.1, 5.5)	1.7 (0.4, 6.5)	1.7 (0.4, 6.5)	1.7 (0.4, 6.5)			
Hemi Resurfacing	1.5 (1.0, 2.4)	4.4 (3.4, 5.8)	7.5 (6.0, 9.2)	11.2 (9.3, 13.4)	12.7 (10.5, 15.3)	13.9 (11.4, 16.8)	
Hemi Mid Head	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	10.0 (1.5, 52.7)				
Hemi Stemmed	2.6 (2.1, 3.1)	5.2 (4.5, 6.0)	6.7 (5.9, 7.6)	7.9 (7.0, 8.9)	8.1 (7.2, 9.2)	8.1 (7.2, 9.2)	

Note: Excludes one humeral ball procedure

Figure SP3 Cumulative Percent Revision of Primary Partial Shoulder Replacement by Shoulder Class



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Hemi Resurfacing	1217	1135	979	783	459	283	113	17
Hemi Stemmed	4048	3449	2849	2247	1164	661	236	26

Primary Partial Resurfacing Shoulder Replacement

Demographics

Primary partial resurfacing replacement is undertaken more commonly in males (76.7%). The median age for females is 67 years compared to 38 years for males (Table SP5 and Figure SP4).

Of the 129 primary partial resurfacing procedures, three have been revised (Table SP3). All were revised to a total conventional shoulder replacement due to glenoid erosion.

The principal diagnosis is osteoarthritis (43.4%), followed by instability (17.1%) and dislocation (16.3%) (Table SP6).

Table SP5 Primary Partial Resurfacing Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	30	23.3%	17	88	67	62.1	17.9
Male	99	76.7%	15	87	38	41.0	18.1
TOTAL	129	100.0%	15	88	45	45.9	20.1

Figure SP4 Primary Partial Resurfacing Shoulder Replacement by Age and Gender

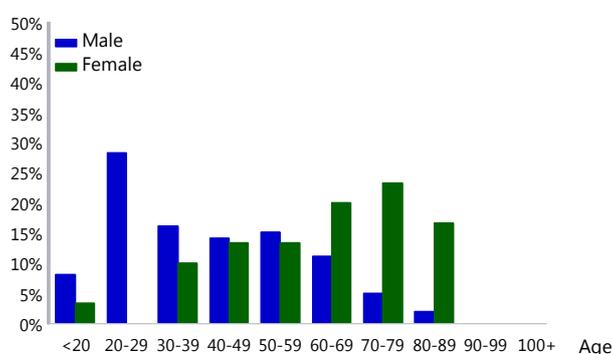


Table SP6 Primary Partial Resurfacing Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	39	39.4	17	56.7	56	43.4
Instability	20	20.2	2	6.7	22	17.1
Dislocation	16	16.2	5	16.7	21	16.3
Hill-Sachs Defect	11	11.1	3	10.0	14	10.9
Fracture	6	6.1	1	3.3	7	5.4
Osteonecrosis	2	2.0	2	6.7	4	3.1
Osteochondritis Dissecans	2	2.0	.	.	2	1.6
Rotator Cuff Arthropathy	2	2.0	.	.	2	1.6
Tumour	1	1.0	.	.	1	0.8
TOTAL	99	100.0	30	100.0	129	100.0

Primary Hemi Resurfacing Shoulder Replacement

Demographics

There have been 1,217 primary hemi resurfacing shoulder replacements reported to the Registry. This is an additional 63 procedures compared to the previous report. The use of primary hemi resurfacing has declined 72.8% since 2008.

This procedure is more common in males (55.5%). The median age for males is 63 years and 70 years for females (Table SP7 and Figure SP5). Osteoarthritis is the principal diagnosis (86.6%) (Table SP8). The three most used prostheses in 2014 were the Copeland followed by Global CAP and SMR (Table SP9).

Table SP7 Primary Hemi Resurfacing Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	542	44.5%	27	93	70	68.9	11.0
Male	675	55.5%	19	90	63	62.0	11.9
TOTAL	1217	100.0%	19	93	66	65.0	12.0

Figure SP5 Primary Hemi Resurfacing Shoulder Replacement by Age and Gender

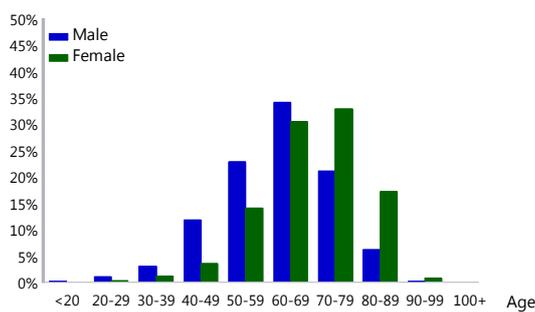


Table SP8 Primary Hemi Resurfacing Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	585	86.7	469	86.5	1054	86.6
Rotator Cuff Arthropathy	47	7.0	32	5.9	79	6.5
Osteonecrosis	15	2.2	15	2.8	30	2.5
Rheumatoid Arthritis	5	0.7	15	2.8	20	1.6
Fracture	9	1.3	3	0.6	12	1.0
Dislocation	5	0.7	3	0.6	8	0.7
Other Inflammatory Arthritis	3	0.4	4	0.7	7	0.6
Instability	6	0.9	1	0.2	7	0.6
TOTAL	675	100.0	542	100.0	1217	100.0

Table SP9 Most Used Humeral Head Prostheses in Primary Hemi Resurfacing Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
124	Copeland	54	Copeland	81	PyroTITAN	34	Copeland	29	Copeland
45	Global CAP	38	PyroTITAN	45	Copeland	33	PyroTITAN	15	Global CAP
34	SMR	35	SMR	22	SMR	19	Global CAP	9	SMR
11	Aequalis	12	Aequalis	19	Global CAP	14	SMR	4	Aequalis
2	Epoca RH	12	Global CAP	11	Aequalis	13	Aequalis	1	Custom Made (Copeland)
1	Buechel-Pappas	3	Epoca RH					1	Epoca RH
Most Used									
217	(6) 100.0%	154	(6) 100.0%	178	(5) 100.0%	113	(5) 100.0%	59	(6) 100.0%

Outcome for All Diagnoses

Reason for Revision

The main reasons for revision of hemi resurfacing replacement are glenoid erosion (26.3%), pain (22.8%) and rotator cuff insufficiency (15.8%) (Table SP10).

Type of Revision

The most common type of revision is to a total shoulder replacement (88.6%) (Table SP11). Of these, 51.5% (52) were revised to a total reverse shoulder and 48.5% (49) to a total conventional shoulder replacement.

Table SP10 Primary Hemi Resurfacing Shoulder Replacement by Reason for Revision

Reason for Revision	Number	Percent
Glenoid Erosion	30	26.3
Pain	26	22.8
Rotator Cuff Insufficiency	18	15.8
Loosening/Lysis	16	14.0
Instability/Dislocation	14	12.3
Infection	2	1.8
Malposition	2	1.8
Implant Breakage Humeral	2	1.8
Arthrofibrosis	1	0.9
Incorrect Sizing	1	0.9
Implant Breakage Head	1	0.9
Other	1	0.9
TOTAL	114	100.0

Outcome for Osteoarthritis

Age and Gender

Age is a risk factor for revision. Those aged 75 years or older have a lower rate of revision after 2.5 years compared to those aged less than 55 years. (Table SP12, Table SP13 and Figure SP6).

Gender is not a risk factor for revision. (Table SP14, Table SP15 and Figure SP7).

The outcomes of the most commonly used prostheses are listed in Table SP16 and Table SP17.

Table SP11 Primary Hemi Resurfacing Shoulder Replacement by Type of Revision

Type of Revision	Number	Percent
Humeral/Glenoid	101	88.6
Glenoid Component	6	5.3
Humeral Component	5	4.4
Removal of Prostheses	1	0.9
Reoperation	1	0.9
TOTAL	114	100.0

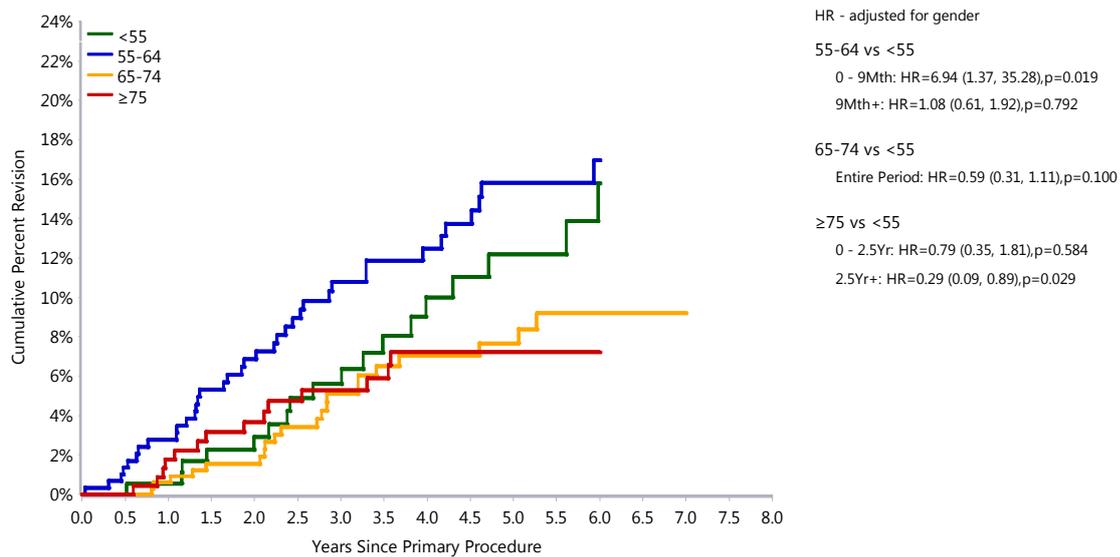
Table SP12 Revision Rates of Primary Hemi Resurfacing Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	19	181	762	2.49 (1.50, 3.89)
55-64	38	295	1181	3.22 (2.28, 4.42)
65-74	21	339	1393	1.51 (0.93, 2.30)
≥75	14	239	988	1.42 (0.77, 2.38)
TOTAL	92	1054	4323	2.13 (1.72, 2.61)

Table SP13 Yearly Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Age (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	0.6 (0.1, 3.9)	2.9 (1.2, 6.8)	5.6 (2.9, 10.5)	12.2 (7.5, 19.4)	15.8 (9.8, 24.9)		
55-64	2.8 (1.4, 5.5)	6.9 (4.4, 10.6)	10.8 (7.6, 15.3)	15.8 (11.5, 21.5)	17.0 (12.3, 23.1)		
65-74	0.6 (0.2, 2.4)	1.6 (0.7, 3.7)	5.1 (3.0, 8.5)	7.7 (4.9, 11.9)	9.2 (6.0, 14.1)	9.2 (6.0, 14.1)	
≥75	1.8 (0.7, 4.7)	3.7 (1.9, 7.2)	5.3 (3.0, 9.4)	7.2 (4.3, 12.0)	7.2 (4.3, 12.0)		

Figure SP6 Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Age (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	181	175	153	123	64	43	22	3
55-64	295	271	234	179	107	70	27	6
65-74	339	320	274	215	131	78	40	4
≥75	239	217	189	159	97	62	15	1

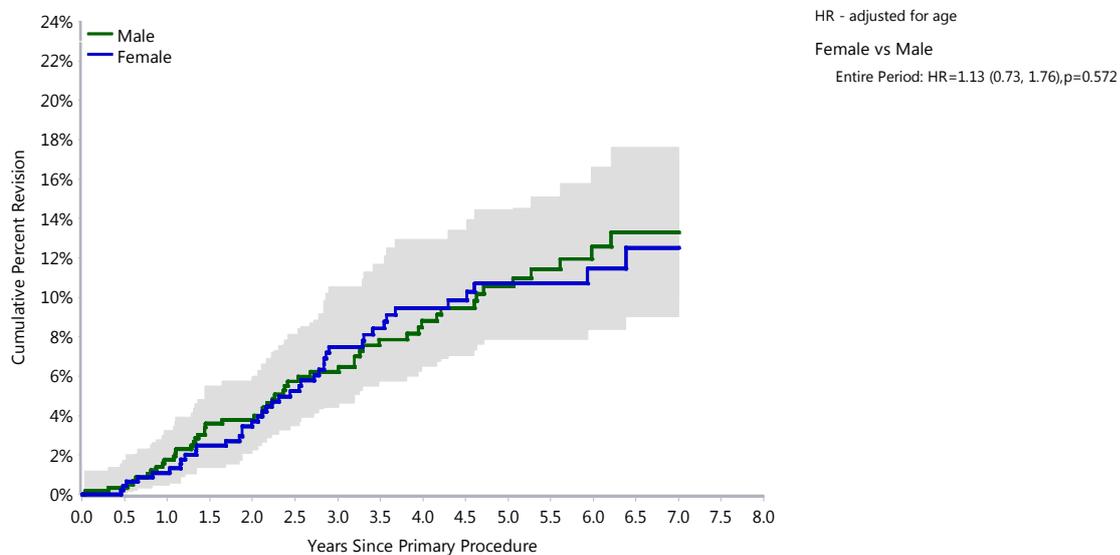
Table SP14 Revision Rates of Primary Hemi Resurfacing Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	51	585	2366	2.16 (1.61, 2.83)
Female	41	469	1958	2.09 (1.50, 2.84)
TOTAL	92	1054	4323	2.13 (1.72, 2.61)

Table SP15 Yearly Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Gender (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	1.8 (0.9, 3.2)	3.8 (2.5, 5.7)	6.2 (4.4, 8.7)	10.6 (7.9, 14.0)	12.6 (9.5, 16.6)	13.3 (10.0, 17.6)	
Female	1.1 (0.5, 2.6)	3.7 (2.3, 6.0)	7.5 (5.3, 10.5)	10.7 (7.9, 14.5)	11.5 (8.4, 15.6)	12.5 (9.0, 17.2)	

Figure SP7 Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Gender (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	585	546	466	360	218	140	57	8
Female	469	437	384	316	181	113	47	6

Table SP16 Revision Rates of Primary Hemi Resurfacing Shoulder Replacement by Humeral Head (Primary Diagnosis OA)

Humeral Head	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	6	73	264	2.27 (0.83, 4.95)
Copeland	39	492	2186	1.78 (1.27, 2.44)
Global CAP	19	181	816	2.33 (1.40, 3.63)
PyroTITAN	10	149	371	2.69 (1.29, 4.95)
SMR	14	136	581	2.41 (1.32, 4.04)
Other (3)	4	23	104	3.84 (1.05, 9.83)
TOTAL	92	1054	4323	2.13 (1.72, 2.61)

Note: Only Humeral Heads with over 50 procedures have been listed

Table SP17 Yearly Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Humeral Head (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	1.4 (0.2, 9.7)	4.6 (1.5, 13.6)	10.4 (4.8, 21.9)	10.4 (4.8, 21.9)	10.4 (4.8, 21.9)		
Copeland	1.5 (0.7, 3.0)	3.4 (2.1, 5.6)	5.4 (3.7, 8.0)	9.3 (6.8, 12.6)	10.3 (7.5, 14.0)	10.3 (7.5, 14.0)	
Global CAP	0.6 (0.1, 4.1)	3.8 (1.7, 8.3)	9.4 (5.7, 15.4)	12.8 (8.2, 19.6)	12.8 (8.2, 19.6)		
PyroTITAN	3.4 (1.4, 7.9)	6.1 (3.2, 11.3)					
SMR	0.0 (0.0, 0.0)	1.6 (0.4, 6.4)	4.3 (1.8, 10.0)	11.7 (6.6, 20.5)			
Other (3)	4.8 (0.7, 29.3)	4.8 (0.7, 29.3)	14.3 (4.8, 38.0)	14.3 (4.8, 38.0)	22.9 (8.7, 52.1)	22.9 (8.7, 52.1)	

Note: Only Humeral Heads with over 50 procedures have been listed

Primary Hemi Mid Head Shoulder Replacement

Demographics and Outcome

There have been 21 primary hemi mid head shoulder replacements reported to the Registry up to and including 31 December 2014. This is an additional three procedures since the previous report.

This procedure is undertaken more commonly in females (52.4%). The median age for females is 67 years and for males is 59 years (Table SP18 and Figure

SP8). Osteoarthritis is the principal diagnosis (66.7%) (Table SP19).

There has been one revision reported for this group of prostheses. The reason for revision was fracture and the revision was to a hemi stemmed shoulder replacement.

Table SP18 Primary Hemi Mid Head Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	11	52.4%	51	85	67	67.9	9.0
Male	10	47.6%	46	83	59	61.0	13.6
TOTAL	21	100.0%	46	85	66	64.6	11.7

Figure SP8 Primary Hemi Mid Head Shoulder Replacement by Age and Gender

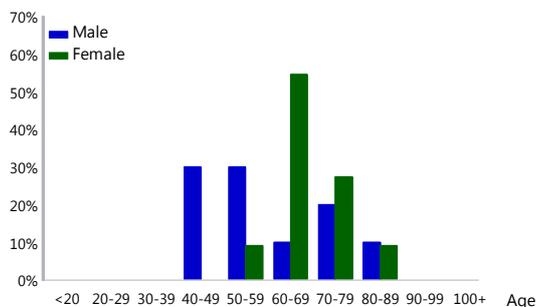


Table SP19 Primary Hemi Mid Head Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	8	80.0	6	54.5	14	66.7
Osteonecrosis	1	10.0	3	27.3	4	19.0
Fracture	.	.	2	18.2	2	9.5
Rotator Cuff Arthropathy	1	10.0	.	.	1	4.8
TOTAL	10	100.0	11	100.0	21	100.0

Primary Hemi Stemmed Shoulder Replacement

Demographics

There have been 4,048 primary hemi stemmed shoulder replacements reported to the Registry. This is an additional 380 procedures since the previous report.

This procedure is more common in females (74.3%). The median age for females is 74 years and 67 years for males (Table SP20 and Figure SP9).

The principal diagnosis is fracture (60.4%), followed by osteoarthritis (25.0%) (Table SP21). The number of primary hemi stemmed shoulder replacements undertaken for fracture has decreased from 351 in 2012 to 205 in 2014. The number of primary hemi stemmed shoulder replacements undertaken for osteoarthritis has decreased from 94 in 2012 to 81 in 2014 (Figure SP10).

The most common humeral stem prostheses used in 2014 were the SMR, Aequalis and Global FX (Table SP22). The 10 most used stem prostheses accounted for 94.5% of all primary hemi stemmed procedures in 2014. This has decreased from 97.2% in 2008.

The most common humeral head prosthesis used in 2014 were the SMR, Aequalis and Global Advantage. (Table SP23). The 10 most used humeral head prostheses accounted for 91.7% of all primary hemi stemmed procedures in 2014. This has decreased from 98.2% in 2008.

Table SP20 Primary Hemi Stemmed Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	3006	74.3%	13	101	74	72.7	10.8
Male	1042	25.7%	14	93	67	66.0	13.0
TOTAL	4048	100.0%	13	101	72	71.0	11.8

Figure SP9 Primary Hemi Stemmed Shoulder Replacement by Age and Gender

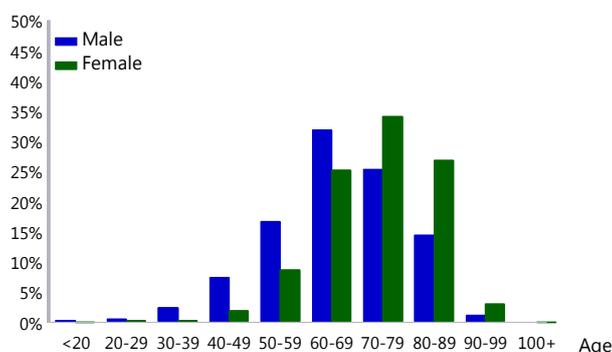


Table SP21 Primary Hemi Stemmed Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Fracture	496	47.6	1948	64.8	2444	60.4
Osteoarthritis	352	33.8	658	21.9	1010	25.0
Rotator Cuff Arthropathy	53	5.1	121	4.0	174	4.3
Osteonecrosis	39	3.7	74	2.5	113	2.8
Dislocation	33	3.2	77	2.6	110	2.7
Tumour	50	4.8	46	1.5	96	2.4
Rheumatoid Arthritis	9	0.9	68	2.3	77	1.9
Other Inflammatory Arthritis	6	0.6	7	0.2	13	0.3
Instability	4	0.4	5	0.2	9	0.2
Other	.	.	2	0.1	2	0.0
TOTAL	1042	100.0	3006	100.0	4048	100.0

Figure SP10 Primary Hemi Stemmed Shoulder Replacement by Primary Diagnosis

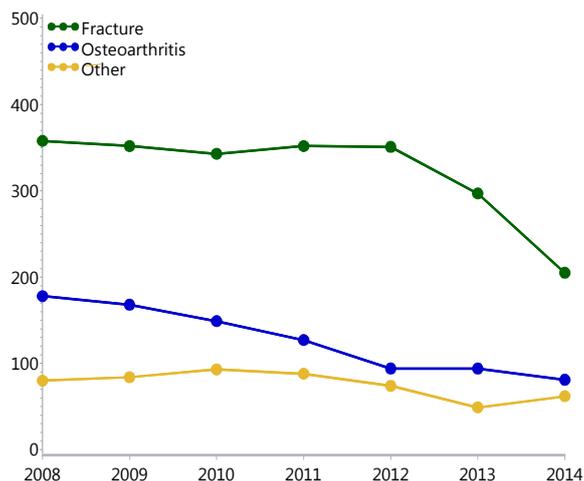


Table SP22 10 Most Used Humeral Stem Prostheses in Primary Hemi Stemmed Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
207	SMR	187	SMR	178	SMR	125	SMR	100	SMR
138	Global FX	106	Aequalis	81	Global FX	66	Global FX	48	Aequalis
98	Aequalis	85	Global FX	79	Aequalis	61	Aequalis	44	Global FX
81	Global Advantage	60	Bigliani/Flatow TM	47	Bigliani/Flatow TM	42	Global AP	38	Global AP
26	Bigliani/Flatow TM	49	Global AP	36	Global AP	36	Global Unite	29	Aequalis Ascend
13	Solar	26	Global Advantage	20	Comprehensive	28	Bigliani/Flatow TM	25	Bigliani/Flatow TM
11	Bigliani/Flatow	13	Comprehensive	20	Global Advantage	25	Comprehensive	22	Global Unite
11	Bio-Modular	7	Solar	15	Global Unite	15	Global Advantage	11	Comprehensive
8	Global AP	7	Trabecular Metal	10	Delta Xtend	7	Delta Xtend	7	Global Advantage
6	Univers 3D	6	Mosaic	5	Solar	4	Ascend	5	Anatomical Shoulder
10 Most Used									
599 (10)	97.2%	546 (10)	96.3%	491 (10)	94.6%	409 (10)	93.0%	329 (10)	94.5%
Remainder									
17 (7)	2.8%	21 (9)	3.7%	28 (15)	5.4%	31 (13)	7.0%	19 (8)	5.5%
TOTAL									
616 (17)	100.0%	567 (19)	100.0%	519 (25)	100.0%	440 (23)	100.0%	348 (18)	100.0%

Table SP23 10 Most Used Humeral Head Prostheses in Primary Hemi Stemmed Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
197	Global Advantage	160	SMR	154	SMR	106	SMR	80	SMR
177	SMR	105	Aequalis	95	Global Advantage	71	Global Advantage	72	Aequalis
98	Aequalis	99	Global Advantage	79	Aequalis	61	Aequalis	47	Global Advantage
38	Bigliani/Flatow	68	Bigliani/Flatow	51	Bigliani/Flatow	36	Global Unite	29	Global AP
31	SMR CTA	29	Global AP	24	SMR CTA	34	Bigliani/Flatow	28	Bigliani/Flatow
22	Global Advantage CTA	27	SMR CTA	20	Global AP	26	Global AP	22	Global Unite
15	Bio-Modular	20	Global AP CTA	16	Global AP CTA	19	SMR CTA	20	SMR CTA
13	Solar	12	Global Advantage CTA	15	Global Unite	16	Global AP CTA	9	Global AP CTA
8	Global AP	7	Bio-Modular	12	Comprehensive	13	Comprehensive	7	Bio-Modular
6	Univers 3D	7	Solar	10	Delta Xtend	12	Bio-Modular	5	Anatomical Shoulder
10 Most Used									
605	(10) 98.2%	534	(10) 94.2%	476	(10) 91.7%	394	(10) 89.5%	319	(10) 91.7%
Remainder									
11	(4) 1.8%	33	(12) 5.8%	43	(16) 8.3%	46	(14) 10.5%	29	(9) 8.3%
TOTAL									
616	(14) 100.0%	567	(22) 100.0%	519	(26) 100.0%	440	(24) 100.0%	348	(19) 100.0%

Outcome for All Diagnoses

Primary Diagnosis

The outcome of primary hemi stemmed shoulder replacement by primary diagnosis is listed in Table SP24 and Table SP25.

There is no difference in the rate of revision when primary hemi stemmed shoulder replacement is performed for fracture or osteoarthritis (Table SP24, Table SP25 and Figure SP11).

Reason for Revision

The most common reasons for revision are instability/dislocation (22.5%), rotator cuff insufficiency (20.6%), pain (13.0%) and glenoid erosion (12.6%) (Table SP26).

Reasons for revision vary depending on primary diagnosis. Rotator cuff insufficiency occurs more frequently in hemi stemmed shoulder replacement undertaken for fracture, whereas glenoid erosion occurs more frequently in those undertaken for osteoarthritis (Table SP27).

Type of Revision

The most common type of revision is total shoulder replacement (62.1%). Of the 157 revised, 145 (92.4%) were revised to a total reverse shoulder replacement. Glenoid component only revision occurs in 13.8% of procedures (Table SP28).

Table SP24 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Fracture	154	2444	8276	1.86 (1.58, 2.18)
Osteoarthritis	69	1010	3937	1.75 (1.36, 2.22)
Rotator Cuff Arthropathy	8	174	578	1.38 (0.60, 2.73)
Osteonecrosis	4	113	451	0.89 (0.24, 2.27)
Dislocation	6	110	433	1.39 (0.51, 3.02)
Other (5)	12	197	548	2.19 (1.13, 3.83)
TOTAL	253	4048	14223	1.78 (1.57, 2.01)

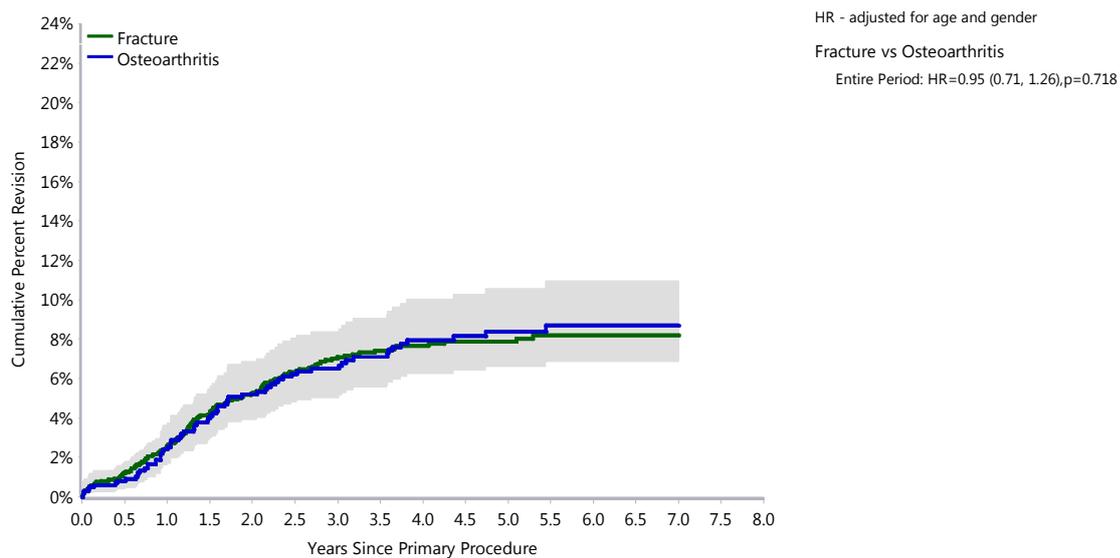
Note: Only Primary Diagnoses with over 100 procedures have been listed

Table SP25 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Primary Diagnosis

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Fracture	2.6 (2.0, 3.4)	5.3 (4.4, 6.3)	7.1 (6.0, 8.3)	7.9 (6.7, 9.2)	8.2 (7.0, 9.6)	8.2 (7.0, 9.6)	8.2 (7.0, 9.6)
Osteoarthritis	2.5 (1.7, 3.8)	5.2 (3.9, 6.9)	6.5 (5.1, 8.4)	8.4 (6.6, 10.6)	8.7 (6.9, 11.0)	8.7 (6.9, 11.0)	8.7 (6.9, 11.0)
Rotator Cuff Arthropathy	1.2 (0.3, 4.7)	2.6 (1.0, 6.8)	5.3 (2.5, 11.0)				
Osteonecrosis	1.0 (0.1, 6.8)	3.0 (1.0, 9.0)	3.0 (1.0, 9.0)	4.6 (1.7, 12.2)			
Dislocation	2.8 (0.9, 8.5)	3.9 (1.5, 10.2)	5.2 (2.2, 12.1)	6.6 (3.0, 14.2)			
Other (5)	4.3 (2.1, 8.8)	8.3 (4.7, 14.2)	8.3 (4.7, 14.2)				

Note: Only Primary Diagnoses with over 100 procedures have been listed

Figure SP11 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Primary Diagnosis



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Fracture	2444	2083	1691	1292	641	352	117	11
Osteoarthritis	1010	886	752	638	365	219	80	6

Table SP26 Primary Hemi Stemmed Shoulder Replacement by Reason for Revision

Reason for Revision	Number	Percent
Instability/Dislocation	57	22.5
Rotator Cuff Insufficiency	52	20.6
Pain	33	13.0
Glenoid Erosion	32	12.6
Loosening/Lysis	23	9.1
Fracture	17	6.7
Infection	15	5.9
Arthrofibrosis	9	3.6
Malposition	7	2.8
Dissociation	4	1.6
Incorrect Sizing	1	0.4
Other	3	1.2
TOTAL	253	100.0

Table SP27 Primary Hemi Stemmed Shoulder Replacement by Reason for Revision and Primary Diagnosis

Reason for Revision	Number	Fracture		Number	Osteoarthritis	
		% Primaries Revised	% Revisions		% Primaries Revised	% Revisions
Rotator Cuff Insufficiency	41	1.7	26.6	8	0.8	11.6
Instability/Dislocation	35	1.4	22.7	15	1.5	21.7
Glenoid Erosion	8	0.3	5.2	19	1.9	27.5
Pain	17	0.7	11.0	10	1.0	14.5
Loosening/Lysis	14	0.6	9.1	8	0.8	11.6
Fracture	12	0.5	7.8	4	0.4	5.8
Infection	10	0.4	6.5	2	0.2	2.9
Arthrofibrosis	6	0.2	3.9	1	0.1	1.4
Malposition	6	0.2	3.9	1	0.1	1.4
Dissociation	2	0.1	1.3	1	0.1	1.4
Incorrect Sizing	1	0.0	0.6			
Other	2	0.1	1.3			
N Revision	154	6.3	100.0	69	6.8	100.0
N Primary	2444			1010		

Table SP28 Primary Hemi Stemmed Shoulder Replacement by Type of Revision

Type of Revision	Number	Percent
Humeral/Glenoid	157	62.1
Glenoid Component	35	13.8
Humeral Component	29	11.5
Head Only	16	6.3
Cement Spacer	6	2.4
Removal of Prostheses	4	1.6
Reoperation	4	1.6
Minor Components	1	0.4
Cement Only	1	0.4
TOTAL	253	100.0

Note: Humeral heads are usually replaced when the humeral component is revised

Outcome for Fracture

Age and Gender

There is no difference in the outcome for patients aged less than 55 years compared to 55 to 64 years or 65 to 74 years. Patients aged 55 years or less have a higher rate of revision compared 75 years or older (Table SP29, Table SP30 and Figure SP12).

There is no difference in outcome by gender (Table SP31, Table SP32 and Figure SP13).

Humeral Stem

There is no difference in the rate of revision for fracture humeral stems compared to other humeral stems (Table SP33, Table SP34 and Figure SP14).

The outcomes of the prostheses used in the treatment of fracture are listed in Table SP35 and Table SP36. The outcomes of these prostheses are also reported separately. Fracture stems are presented separately in Table SP37 and Table SP38 and other humeral stems (non-fracture) in Table SP39 and Table SP40.

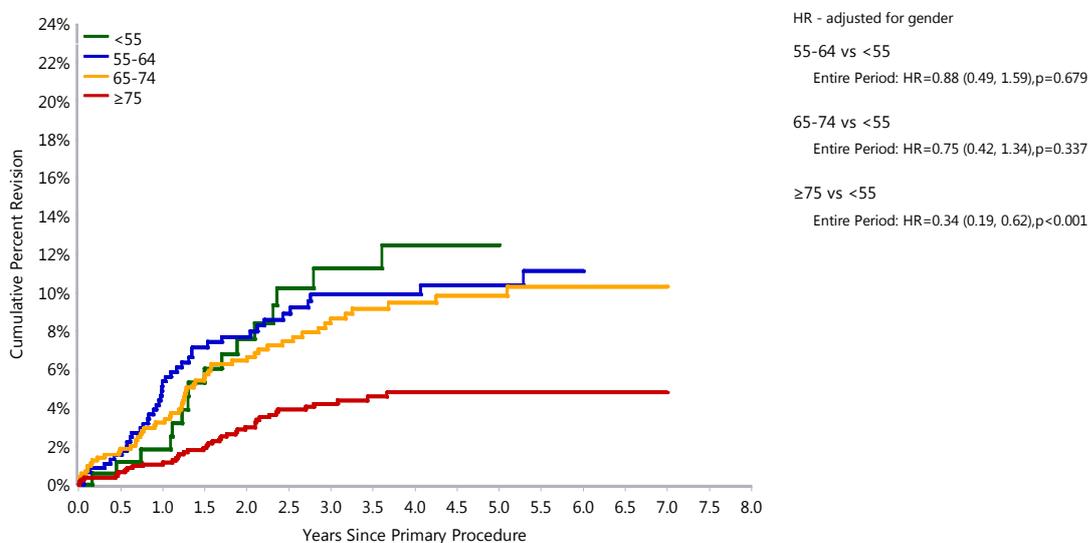
Table SP29 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Age (Primary Diagnosis Fracture)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	16	171	563	2.84 (1.62, 4.61)
55-64	42	462	1609	2.61 (1.88, 3.53)
65-74	56	709	2410	2.32 (1.76, 3.02)
≥75	40	1102	3695	1.08 (0.77, 1.47)
TOTAL	154	2444	8276	1.86 (1.58, 2.18)

Table SP30 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Age (Primary Diagnosis Fracture)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	1.8 (0.6, 5.6)	7.6 (4.3, 13.3)	11.3 (6.9, 18.1)	12.5 (7.7, 19.8)			
55-64	5.4 (3.6, 8.0)	7.7 (5.5, 10.7)	9.9 (7.3, 13.4)	10.4 (7.7, 14.0)	11.1 (8.2, 15.1)		
65-74	3.3 (2.2, 4.9)	6.7 (5.0, 8.9)	8.7 (6.6, 11.3)	9.8 (7.6, 12.7)	10.3 (7.9, 13.4)	10.3 (7.9, 13.4)	
≥75	1.2 (0.7, 2.0)	3.0 (2.1, 4.3)	4.2 (3.1, 5.8)	4.8 (3.5, 6.5)	4.8 (3.5, 6.5)	4.8 (3.5, 6.5)	4.8 (3.5, 6.5)

Figure SP12 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Age (Primary Diagnosis Fracture)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	171	149	116	82	42	23	10	0
55-64	462	385	318	257	134	81	17	0
65-74	709	603	486	372	188	102	42	6
≥75	1102	946	771	581	277	146	48	5

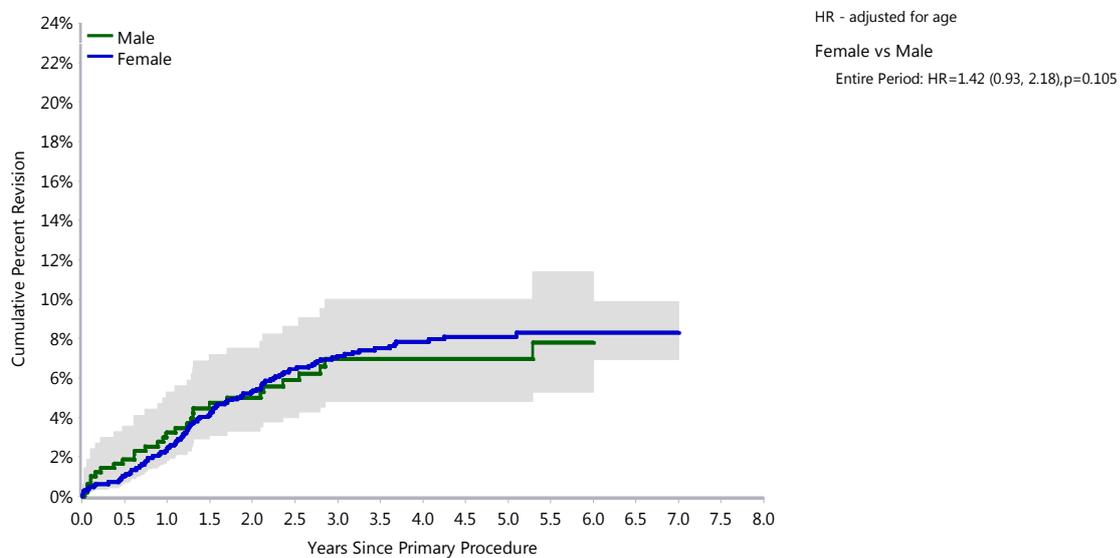
Table SP31 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Gender (Primary Diagnosis Fracture)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	29	496	1634	1.77 (1.19, 2.55)
Female	125	1948	6642	1.88 (1.57, 2.24)
TOTAL	154	2444	8276	1.86 (1.58, 2.18)

Table SP32 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Gender (Primary Diagnosis Fracture)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	3.2 (2.0, 5.3)	5.0 (3.3, 7.5)	7.0 (4.8, 10.0)	7.0 (4.8, 10.0)	7.8 (5.3, 11.4)		
Female	2.5 (1.9, 3.3)	5.4 (4.4, 6.5)	7.1 (6.0, 8.5)	8.1 (6.8, 9.6)	8.3 (6.9, 9.9)	8.3 (6.9, 9.9)	

Figure SP13 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Gender (Primary Diagnosis Fracture)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	496	411	337	245	128	72	22	1
Female	1948	1672	1354	1047	513	280	95	10

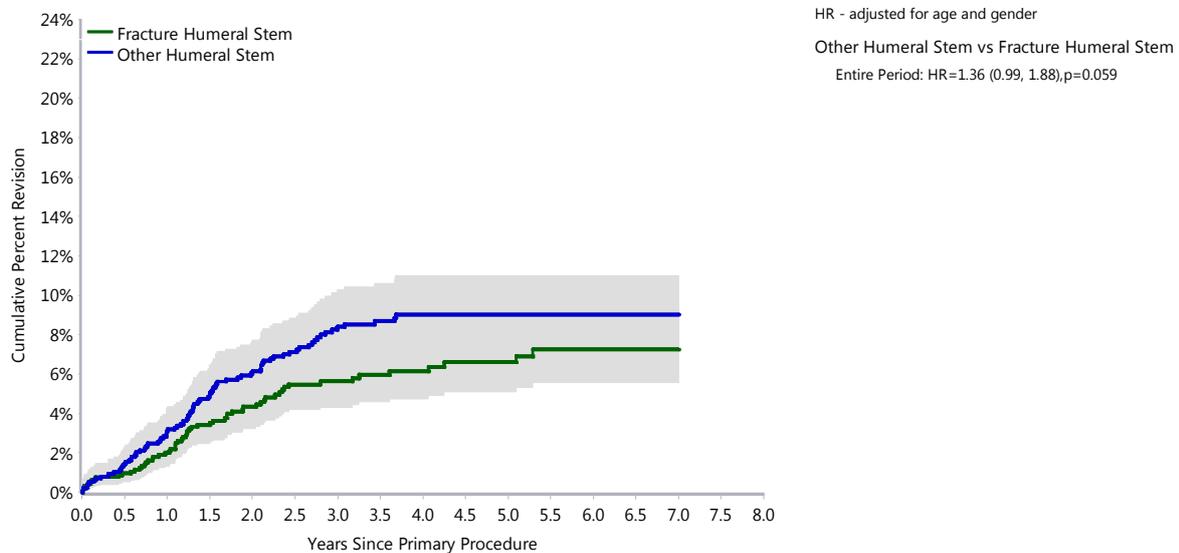
Table SP33 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Stem Type (Primary Diagnosis Fracture)

Fracture	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Fracture Humeral Stem	61	1170	3952	1.54 (1.18, 1.98)
Other Humeral Stem	93	1274	4324	2.15 (1.74, 2.63)
TOTAL	154	2444	8276	1.86 (1.58, 2.18)

Table SP34 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Stem Type (Primary Diagnosis Fracture)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Fracture Humeral Stem	2.0 (1.3, 3.0)	4.3 (3.2, 5.8)	5.6 (4.3, 7.3)	6.6 (5.1, 8.5)	7.2 (5.6, 9.4)	7.2 (5.6, 9.4)	
Other Humeral Stem	3.2 (2.3, 4.4)	6.1 (4.9, 7.7)	8.4 (6.8, 10.3)	9.0 (7.4, 11.0)	9.0 (7.4, 11.0)	9.0 (7.4, 11.0)	9.0 (7.4, 11.0)

Figure SP14 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Stem Type (Primary Diagnosis Fracture)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Fracture Humeral Stem	1170	993	791	613	312	185	65	5
Other Humeral Stem	1274	1090	900	679	329	167	52	6

Table SP35 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Stem (Primary Diagnosis Fracture)

Humeral Head	Humeral Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	14	384	1265	1.11 (0.60, 1.86)
Bigliani/Flatow	Bigliani/Flatow TM	6	253	822	0.73 (0.27, 1.59)
Bio-Modular	Comprehensive	0	50	164	0.00 (0.00, 2.25)
Global Advantage	Global Advantage	8	48	209	3.83 (1.65, 7.54)
Global Advantage	Global FX	40	633	2390	1.67 (1.20, 2.28)
Global Unite	Global Unite	6	66	81	7.43 (2.73, 16.17)
SMR	SMR	67	766	2549	2.63 (2.04, 3.34)
SMR CTA	SMR	2	32	96	2.09 (0.25, 7.55)
Solar	Solar	4	39	150	2.67 (0.73, 6.85)
Other (24)		7	173	552	1.27 (0.51, 2.61)
TOTAL		154	2444	8276	1.86 (1.58, 2.18)

Note: Only combinations with over 30 procedures have been listed.

Table SP36 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Stem (Primary Diagnosis Fracture)

Humeral Head	Humeral Stem	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	Aequalis	2.2 (1.1, 4.3)	3.4 (2.0, 6.0)	3.8 (2.2, 6.5)	4.4 (2.6, 7.5)	4.4 (2.6, 7.5)		
Bigliani/Flatow	Bigliani/Flatow TM	1.3 (0.4, 4.0)	2.2 (0.9, 5.3)	2.9 (1.3, 6.3)	2.9 (1.3, 6.3)			
Bio-Modular	Comprehensive	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)		
Global Advantage	Global Advantage	6.5 (2.2, 18.9)	8.7 (3.4, 21.7)	16.1 (8.0, 31.0)	18.8 (9.8, 34.3)	18.8 (9.8, 34.3)		
Global Advantage	Global FX	2.2 (1.3, 3.7)	4.4 (3.0, 6.4)	6.3 (4.5, 8.7)	7.5 (5.5, 10.2)	8.4 (6.1, 11.5)	8.4 (6.1, 11.5)	
Global Unite	Global Unite	1.8 (0.3, 12.0)	20.4 (8.8, 43.0)					
SMR	SMR	3.5 (2.4, 5.1)	7.5 (5.7, 9.7)	10.1 (7.9, 12.8)	10.9 (8.6, 13.8)	10.9 (8.6, 13.8)		
SMR CTA	SMR	3.7 (0.5, 23.5)	3.7 (0.5, 23.5)	9.1 (2.3, 32.3)	9.1 (2.3, 32.3)			
Solar	Solar	8.1 (2.7, 23.1)	10.8 (4.2, 26.3)	10.8 (4.2, 26.3)	10.8 (4.2, 26.3)	10.8 (4.2, 26.3)		
Other (24)		1.9 (0.6, 5.9)	4.2 (1.9, 9.2)	5.3 (2.5, 11.0)	5.3 (2.5, 11.0)			

Note: Only combinations with over 30 procedures have been listed.

Table SP37 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Fracture Stem (Primary Diagnosis Fracture)

Humeral Head	Fracture Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	13	370	1208	1.08 (0.57, 1.84)
Affinis	Affinis	2	16	36	5.51 (0.67, 19.89)
Anatomical Shoulder	Anatomical Shoulder	0	5	3	0.00 (0.00, 124.6)
Ascend	Aequalis	0	1	2	0.00 (0.00, 201.4)
Bio-Modular	Comprehensive	0	50	164	0.00 (0.00, 2.25)
Comprehensive	Comprehensive	0	19	41	0.00 (0.00, 9.09)
Equinox	Equinox	0	2	1	0.00 (0.00, 284.9)
Global Advantage	Global FX	40	633	2390	1.67 (1.20, 2.28)
Global Advantage CTA	Global FX	0	8	27	0.00 (0.00, 13.69)
Global Unite	Global Unite	6	66	81	7.43 (2.73, 16.17)
TOTAL		61	1170	3952	1.54 (1.18, 1.98)

Table SP38 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Fracture Stem (Primary Diagnosis Fracture)

Humeral Head	Fracture Stem	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	Aequalis	2.0 (0.9, 4.1)	3.3 (1.8, 5.9)	3.7 (2.1, 6.4)	4.3 (2.5, 7.5)	4.3 (2.5, 7.5)		
Bio-Modular	Comprehensive	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)		
Global Advantage	Global FX	2.2 (1.3, 3.7)	4.4 (3.0, 6.4)	6.3 (4.5, 8.7)	7.5 (5.5, 10.2)	8.4 (6.1, 11.5)	8.4 (6.1, 11.5)	
Global Unite	Global Unite	1.8 (0.3, 12.0)	20.4 (8.8, 43.0)					
Other (6)		2.6 (0.4, 17.2)	5.5 (1.4, 20.3)	5.5 (1.4, 20.3)				

Note: Only combinations with over 30 procedures have been listed.

Table SP39 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Other Humeral Stem (Primary Diagnosis Fracture)

Humeral Head	Other Humeral Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Bigliani/Flatow	Bigliani/Flatow TM	6	253	822	0.73 (0.27, 1.59)
Global Advantage	Global Advantage	8	48	209	3.83 (1.65, 7.54)
SMR	SMR	67	766	2549	2.63 (2.04, 3.34)
SMR CTA	SMR	2	32	96	2.09 (0.25, 7.55)
Solar	Solar	4	39	150	2.67 (0.73, 6.85)
Other (23)		6	136	500	1.20 (0.44, 2.61)
TOTAL		93	1274	4324	2.15 (1.74, 2.63)

Note: Only combinations with over 30 procedures have been listed.

Table SP40 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Other Humeral Stem (Primary Diagnosis Fracture)

Humeral Head	Other Humeral Stem	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Bigliani/Flatow	Bigliani/Flatow TM	1.3 (0.4, 4.0)	2.2 (0.9, 5.3)	2.9 (1.3, 6.3)	2.9 (1.3, 6.3)			
Global Advantage	Global Advantage	6.5 (2.2, 18.9)	8.7 (3.4, 21.7)	16.1 (8.0, 31.0)	18.8 (9.8, 34.3)	18.8 (9.8, 34.3)		
SMR	SMR	3.5 (2.4, 5.1)	7.5 (5.7, 9.7)	10.1 (7.9, 12.8)	10.9 (8.6, 13.8)	10.9 (8.6, 13.8)		
SMR CTA	SMR	3.7 (0.5, 23.5)	3.7 (0.5, 23.5)	9.1 (2.3, 32.3)	9.1 (2.3, 32.3)			
Solar	Solar	8.1 (2.7, 23.1)	10.8 (4.2, 26.3)	10.8 (4.2, 26.3)	10.8 (4.2, 26.3)	10.8 (4.2, 26.3)		
Other (23)		2.3 (0.8, 7.1)	4.2 (1.8, 9.8)	5.3 (2.4, 11.6)	5.3 (2.4, 11.6)			

Note: Only combinations with over 30 procedures have been listed.

Outcome for Osteoarthritis

Age and Gender

There is no difference in the rate of revision when patients aged less than 55 years are compared to those aged 55 to 64 years. The rate of revision is lower for the two older age groups (65 to 74 years and 75 years and older) compared to patients aged less than 55 years (Table SP41, Table SP42 and Figure SP15). Gender is not a risk factor for revision. (Table SP43, Table SP44 and Figure SP16).

Humeral Head

There is no difference in the rate of revision when a CTA humeral head is used compared to a standard head (Table SP45, Table SP46 and Figure SP17).

The outcomes for the most used prostheses for osteoarthritis are listed in Table SP47 and Table SP48.

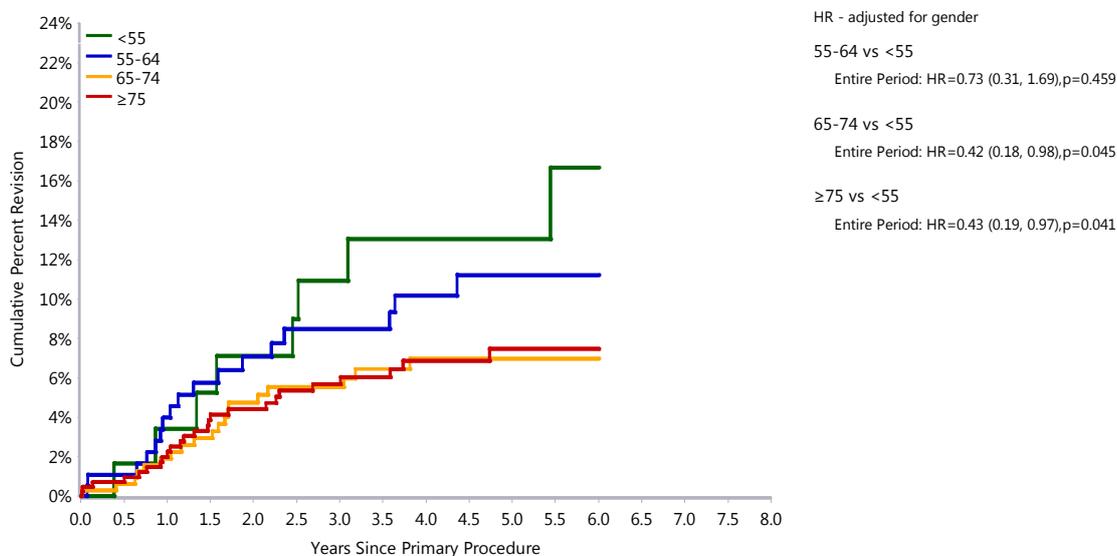
Table SP41 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	8	69	267	2.99 (1.29, 5.90)
55-64	17	187	727	2.34 (1.36, 3.74)
65-74	19	329	1310	1.45 (0.87, 2.26)
≥75	25	425	1633	1.53 (0.99, 2.26)
TOTAL	69	1010	3937	1.75 (1.36, 2.22)

Table SP42 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Age (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	3.4 (0.9, 13.0)	7.1 (2.7, 17.9)	10.9 (5.1, 22.8)	13.1 (6.4, 25.5)	16.7 (8.4, 31.6)		
55-64	4.0 (1.9, 8.2)	7.1 (4.1, 12.1)	8.5 (5.1, 14.0)	11.2 (7.0, 17.6)	11.2 (7.0, 17.6)		
65-74	1.9 (0.9, 4.2)	4.8 (2.8, 7.9)	5.5 (3.4, 8.9)	7.0 (4.5, 10.8)	7.0 (4.5, 10.8)		
≥75	2.3 (1.2, 4.3)	4.4 (2.8, 7.0)	5.7 (3.7, 8.6)	7.5 (5.0, 11.0)	7.5 (5.0, 11.0)		

Figure SP15 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Age (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	69	55	49	42	30	17	7	0
55-64	187	164	138	119	63	40	12	2
65-74	329	294	248	210	127	77	25	1
≥75	425	373	317	267	145	85	36	3

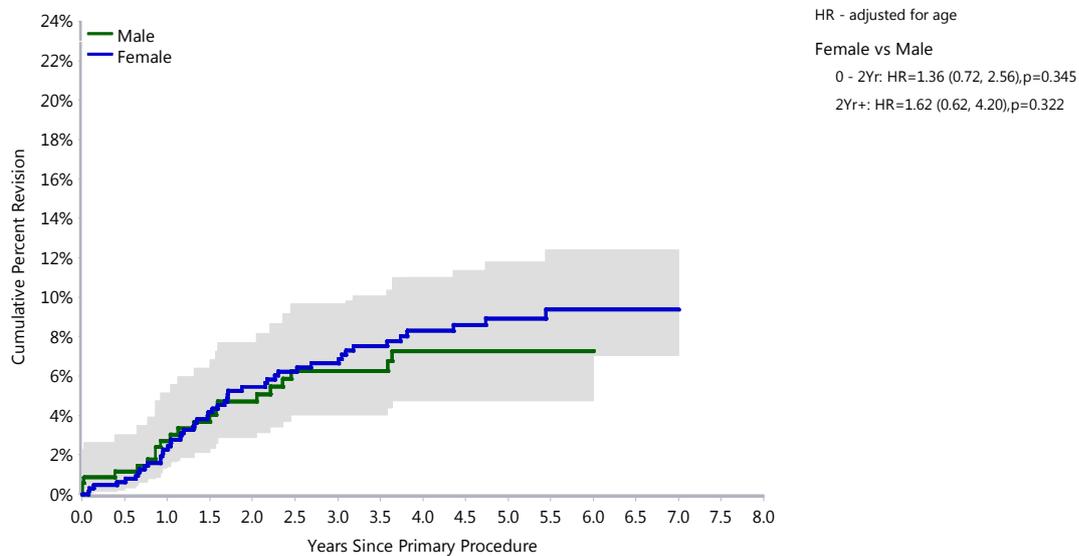
Table SP43 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	21	352	1323	1.59 (0.98, 2.43)
Female	48	658	2614	1.84 (1.35, 2.43)
TOTAL	69	1010	3937	1.75 (1.36, 2.22)

Table SP44 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Gender (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	2.7 (1.4, 5.2)	4.7 (2.9, 7.7)	6.3 (4.0, 9.7)	7.3 (4.8, 11.0)	7.3 (4.8, 11.0)		
Female	2.4 (1.5, 4.0)	5.4 (3.9, 7.6)	6.6 (4.9, 9.0)	8.9 (6.7, 11.8)	9.4 (7.1, 12.4)	9.4 (7.1, 12.4)	

Figure SP16 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Gender (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	352	306	260	210	115	70	22	3
Female	658	580	492	428	250	149	58	3

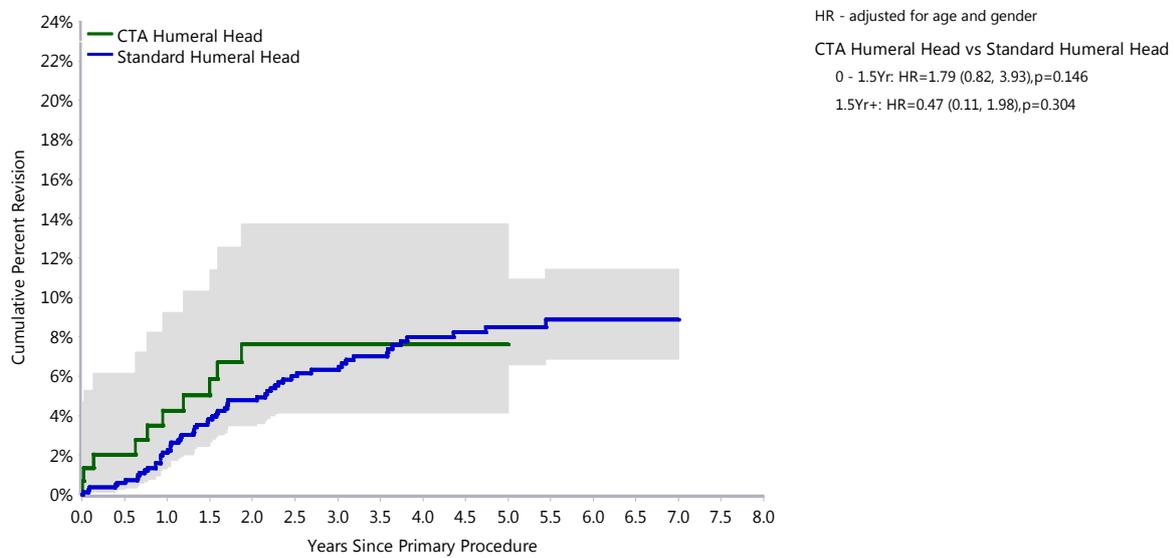
Table SP45 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Head Type (Primary Diagnosis OA)

Head Type	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
CTA Humeral Head	10	148	574	1.74 (0.83, 3.20)
Standard Humeral Head	59	862	3362	1.75 (1.34, 2.26)
TOTAL	69	1010	3937	1.75 (1.36, 2.22)

Table SP46 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Head Type (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
CTA Humeral Head	4.3 (1.9, 9.2)	7.6 (4.2, 13.7)	7.6 (4.2, 13.7)	7.6 (4.2, 13.7)			
Standard Humeral Head	2.2 (1.4, 3.5)	4.8 (3.5, 6.6)	6.3 (4.8, 8.3)	8.5 (6.6, 10.9)	8.9 (6.9, 11.4)	8.9 (6.9, 11.4)	

Figure SP17 Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Head Type (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
CTA Humeral Head	148	125	101	88	61	38	16	1
Standard Humeral Head	862	761	651	550	304	181	64	5

Table SP47 Revision Rates of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Stem (Primary Diagnosis OA)

Humeral Head	Humeral Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	5	133	519	0.96 (0.31, 2.25)
Bigliani/Flatow	Bigliani/Flatow TM	3	48	183	1.64 (0.34, 4.78)
Delta Xtend	Delta Xtend	1	22	69	1.46 (0.04, 8.11)
Global AP	Global AP	5	115	308	1.62 (0.53, 3.79)
Global AP CTA	Global AP	3	33	87	3.44 (0.71, 10.07)
Global Advantage	Global Advantage	11	142	708	1.55 (0.78, 2.78)
Global Advantage	Global FX	3	28	100	3.01 (0.62, 8.79)
Global Advantage CTA	Global Advantage	0	36	194	0.00 (0.00, 1.90)
SMR	SMR	25	259	1105	2.26 (1.46, 3.34)
SMR CTA	SMR	6	77	288	2.08 (0.76, 4.54)
Other (24)		7	117	376	1.86 (0.75, 3.84)
TOTAL		69	1010	3937	1.75 (1.36, 2.22)

Note: Only combinations with over 20 procedures have been listed

Table SP48 Yearly Cumulative Percent Revision of Primary Hemi Stemmed Shoulder Replacement by Humeral Head and Stem (Primary Diagnosis OA)

Humeral Head	Humeral Stem	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	Aequalis	1.6 (0.4, 6.2)	4.3 (1.8, 10.0)	4.3 (1.8, 10.0)	4.3 (1.8, 10.0)			
Bigliani/Flatow	Bigliani/Flatow TM	4.6 (1.2, 17.0)	6.9 (2.3, 20.0)	6.9 (2.3, 20.0)	6.9 (2.3, 20.0)			
Delta Xtend	Delta Xtend	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	7.1 (1.0, 40.9)	7.1 (1.0, 40.9)			
Global AP	Global AP	0.0 (0.0, 0.0)	4.9 (1.9, 12.6)	4.9 (1.9, 12.6)				
Global AP CTA	Global AP	3.0 (0.4, 19.6)	10.1 (3.4, 28.3)	10.1 (3.4, 28.3)				
Global Advantage	Global Advantage	0.7 (0.1, 4.9)	2.9 (1.1, 7.5)	5.2 (2.5, 10.6)	7.9 (4.3, 14.2)	9.1 (5.1, 15.9)		
Global Advantage	Global FX	3.8 (0.6, 24.3)	7.7 (2.0, 27.4)	13.1 (4.3, 36.0)	13.1 (4.3, 36.0)	13.1 (4.3, 36.0)		
Global Advantage CTA	Global Advantage	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	
SMR	SMR	4.0 (2.2, 7.3)	6.5 (4.1, 10.4)	7.9 (5.1, 12.1)	11.3 (7.7, 16.3)	11.3 (7.7, 16.3)		
SMR CTA	SMR	5.5 (2.1, 14.0)	8.9 (4.1, 18.8)	8.9 (4.1, 18.8)	8.9 (4.1, 18.8)	8.9 (4.1, 18.8)		
Other (24)		3.2 (1.0, 9.5)	4.4 (1.7, 11.2)	7.2 (3.2, 15.4)				

Note: Only combinations with over 20 procedures have been listed

PRIMARY TOTAL SHOULDER REPLACEMENT

Classes of Total Shoulder Replacement

The Registry sub-categorises primary total shoulder replacement into four classes. These are defined by the type of prostheses used.

1. **Total resurfacing** includes glenoid replacement and the use of a humeral prosthesis that replaces the humeral articular surface without resecting the head.
2. **Total mid head** includes glenoid replacement combined with resection of part of the humeral head and replacement with a cone stemmed humeral head prosthesis.
3. **Total conventional** includes glenoid replacement combined with resection of the humeral head and replacement with a stemmed humeral prosthesis and humeral head prosthesis.
4. **Total reverse** includes glenoid replacement with a glenoid head prosthesis combined with resection of the humeral head and replacement with a stemmed humeral prosthesis and humeral cup prosthesis.

Use of Total Shoulder Replacement

There have been 19,059 total shoulder replacements reported to the Registry. This is an additional 3,753 procedures compared to the previous report.

Most procedures are performed on females (62.4%). The median age is 74 years for females and 71 years for males (Table ST1 and Figure ST1).

The principal diagnosis is osteoarthritis (69.6%), followed by rotator cuff arthropathy (17.3%) and fracture (7.6%). Rheumatoid arthritis and osteonecrosis account for 2.3% and 1.3%, respectively (Table ST2).

The two main classes of primary total shoulder replacement are total conventional (46.7%) and total reverse (50.8%). Total resurfacing and total mid head

replacement are used infrequently (0.9% and 1.5%, respectively) (Table ST3). The proportion of total shoulder replacements that are total reverse has increased from 43.7% in 2010 to 60.3% in 2014 (Figure ST2).

Only 181 total resurfacing replacements have been reported to the Registry, 10 have been revised. The cumulative percent revision at three years is 6.4%.

Total mid head replacement has been used in 290 procedures. There have been three revisions and the two year cumulative percent revision is 1.4%.

At seven years, the cumulative percent revision for total conventional and total reverse shoulder replacement is 9.4% and 5.4%, respectively. Total reverse shoulder replacement has a higher rate of revision compared to total conventional in the first three months. However, after three months, total reverse shoulder replacement has a lower rate of revision (Table ST3, Table ST4 and Figure ST3).

An additional analysis was performed excluding SMR prostheses from both total conventional and total reverse shoulder replacement. These prostheses have a higher than anticipated rate of revision and account for a high proportion of procedures in each class (total conventional 28.5% and total reverse 33.4%).

After excluding the SMR prosthesis, total reverse shoulder replacement continues to have a higher rate of revision in the first three months and a lower rate of revision after this time. The seven year cumulative percent revision for total conventional and total reverse shoulder replacement is 5.7% and 5.0% respectively (Table ST5, Table ST6 and Figure ST4).

Table ST1 Primary Total Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	11895	62.4%	14	102	74	73.6	8.6
Male	7164	37.6%	24	96	71	70.1	9.1
TOTAL	19059	100.0%	14	102	73	72.3	9.0

Figure ST1 Primary Total Shoulder Replacement by Age and Gender

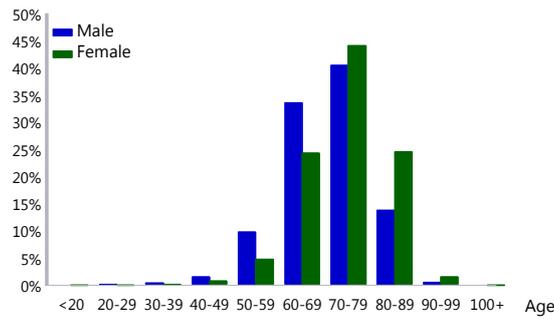


Table ST2 Primary Total Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	5320	74.3	7940	66.8	13260	69.6
Rotator Cuff Arthropathy	1343	18.7	1954	16.4	3297	17.3
Fracture	218	3.0	1239	10.4	1457	7.6
Rheumatoid Arthritis	99	1.4	337	2.8	436	2.3
Osteonecrosis	45	0.6	196	1.6	241	1.3
Dislocation	26	0.4	89	0.7	115	0.6
Tumour	46	0.6	44	0.4	90	0.5
Other Inflammatory Arthritis	29	0.4	55	0.5	84	0.4
Instability	30	0.4	35	0.3	65	0.3
Other	8	0.1	6	0.1	14	0.1
TOTAL	7164	100.0	11895	100.0	19059	100.0

Figure ST2 Proportion of Primary Total Shoulders by Shoulder Class

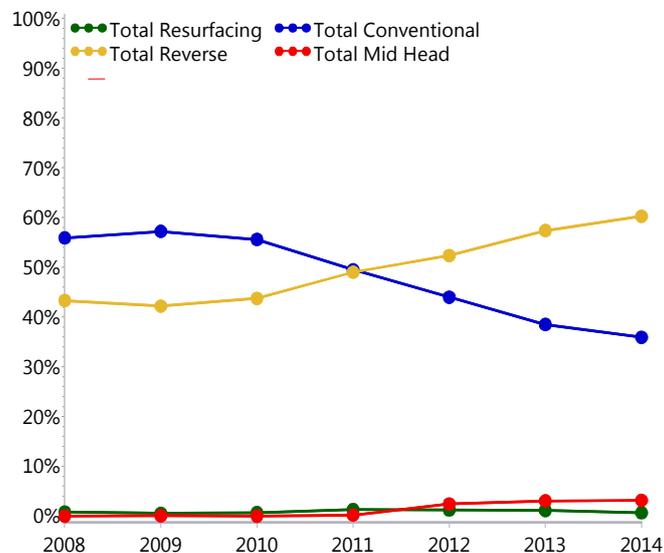


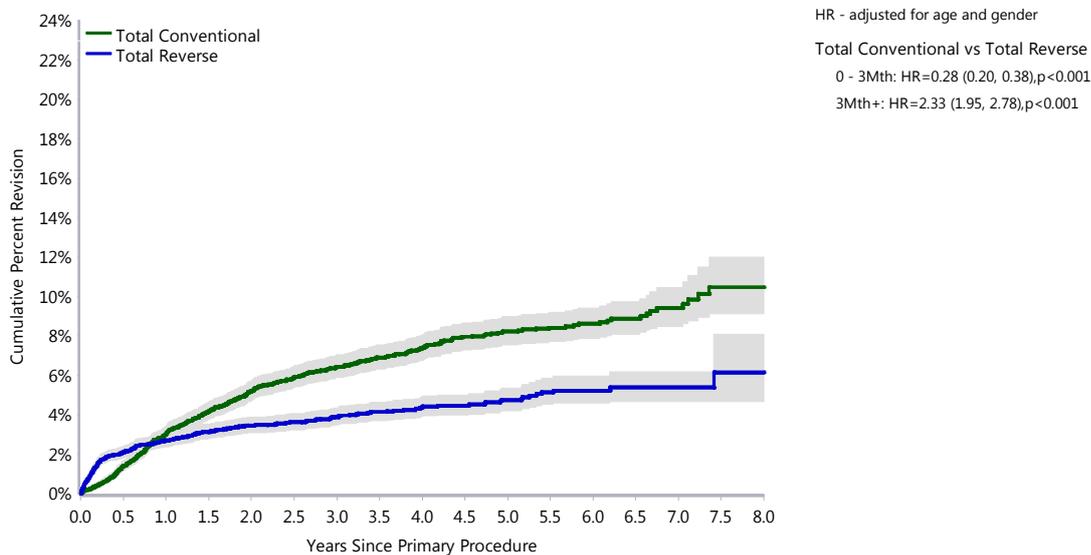
Table ST3 Revision Rates of Primary Total Shoulder Replacement by Shoulder Class

Shoulder Class	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Total Resurfacing	10	181	540	1.85 (0.89, 3.40)
Total Mid Head	3	290	390	0.77 (0.16, 2.25)
Total Conventional	550	8906	29226	1.88 (1.73, 2.05)
Total Reverse	341	9682	25223	1.35 (1.21, 1.50)
TOTAL	904	19059	55380	1.63 (1.53, 1.74)

Table ST4 Yearly Cumulative Percent Revision of Primary Total Shoulder Replacement by Shoulder Class

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Total Resurfacing	2.4 (0.9, 6.2)	5.2 (2.6, 10.2)	6.4 (3.3, 12.2)				
Total Mid Head	1.4 (0.4, 4.2)	1.4 (0.4, 4.2)					
Total Conventional	3.1 (2.7, 3.5)	5.2 (4.7, 5.7)	6.4 (5.9, 7.0)	8.2 (7.6, 9.0)	8.6 (7.9, 9.4)	9.4 (8.5, 10.5)	10.5 (9.1, 12.0)
Total Reverse	2.7 (2.4, 3.1)	3.5 (3.1, 3.9)	3.9 (3.5, 4.4)	4.8 (4.2, 5.4)	5.2 (4.6, 6.0)	5.4 (4.7, 6.2)	6.2 (4.7, 8.1)

Figure ST3 Cumulative Percent Revision of Primary Total Shoulder Replacement by Shoulder Class



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Total Conventional	8906	7287	5860	4547	2184	1172	443	77
Total Reverse	9682	7123	5158	3607	1464	737	262	45

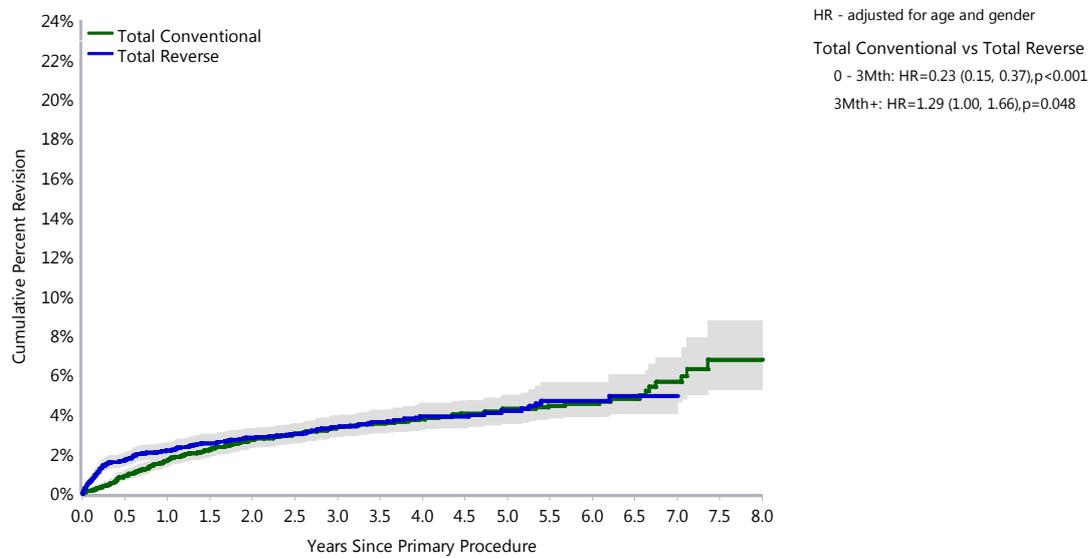
Table ST5 Revision Rates of Primary Total Shoulder Replacement by Shoulder Class (excluding SMR)

Shoulder Class	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Total Conventional	208	6366	20788	1.00 (0.87, 1.15)
Total Reverse	192	6445	16154	1.19 (1.03, 1.37)
TOTAL	400	12811	36942	1.08 (0.98, 1.19)

Table ST6 Yearly Cumulative Percent Revision of Primary Shoulder Replacement by Shoulder Class (excluding SMR)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Total Conventional	1.7 (1.4, 2.1)	2.7 (2.3, 3.2)	3.4 (2.9, 3.9)	4.3 (3.7, 5.0)	4.6 (3.9, 5.3)	5.7 (4.6, 6.9)	6.8 (5.3, 8.8)
Total Reverse	2.2 (1.8, 2.6)	2.8 (2.4, 3.3)	3.4 (2.9, 4.0)	4.2 (3.6, 5.0)	4.7 (3.9, 5.6)	5.0 (4.1, 6.0)	

Figure ST4 Cumulative Percent Revision of Primary Shoulder Replacement by Shoulder Class (excluding SMR)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Total Conventional	6366	5192	4196	3233	1530	797	308	54
Total Reverse	6445	4648	3280	2248	908	438	156	29

Primary Total Resurfacing Shoulder Replacement

Demographics and Outcome

There have been 181 primary total resurfacing replacements reported to the Registry, an additional 24 procedures compared to the previous report.

Primary total resurfacing replacement is undertaken more often in males (61.9%). The median age is 68 years for females and 63 years for males (Table ST7 and Figure ST5).

Osteoarthritis is the principal diagnosis (94.5%) (Table ST8).

There were three different types of total resurfacing prostheses used in 2014. The Global CAP and Global

remain the most used humeral head and glenoid prostheses, respectively with 17 of the 24 procedures reported in 2014 (Table ST9 and Table ST10).

There have been 10 revisions of primary total resurfacing shoulder replacement. The main reasons for revision are instability/dislocation, infection and implant breakage of the glenoid insert (Table ST11). The most common type of revision involves replacing only the humeral component (40.0%) (Table ST12).

Table ST7 Primary Total Resurfacing Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	69	38.1%	46	86	68	66.8	7.2
Male	112	61.9%	35	83	63	61.9	9.8
TOTAL	181	100.0%	35	86	65	63.8	9.2

Figure ST5 Primary Total Resurfacing Shoulder Replacement by Age and Gender

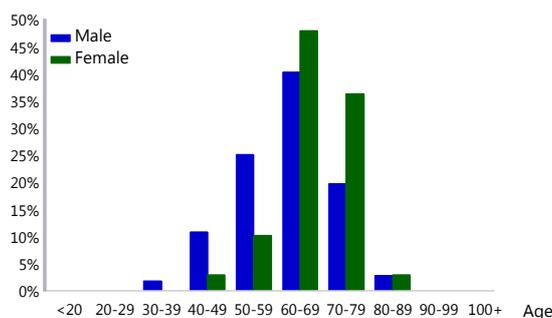


Table ST8 Primary Total Resurfacing Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	107	95.5	64	92.8	171	94.5
Rheumatoid Arthritis	1	0.9	2	2.9	3	1.7
Fracture	1	0.9	1	1.4	2	1.1
Other Inflammatory Arthritis	.	.	1	1.4	1	0.6
Dislocation	1	0.9	.	.	1	0.6
Rotator Cuff Arthropathy	.	.	1	1.4	1	0.6
Osteonecrosis	1	0.9	.	.	1	0.6
Other	1	0.9	.	.	1	0.6
TOTAL	112	100.0	69	100.0	181	100.0

Table ST9 Most Used Humeral Head Prostheses in Primary Total Resurfacing Shoulder Replacement

2008		2009		2010		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
5	SMR	5	Epoca RH	7	Global CAP	30	Global CAP	31	Global CAP	27	Global CAP	17	Global CAP
4	Aequalis	3	SMR	5	SMR	3	SMR	4	Aequalis	5	Aequalis	6	Aequalis
2	Copeland	2	Copeland	2	Epoca RH	1	Epoca RH	1	SMR	3	Epoca RH	1	Epoca RH
1	Global CAP	1	Aequalis	1	Aequalis					1	SMR		
Most Used													
12	(4) 100.0%	11	(4) 100.0%	15	(4) 100.0%	34	(3) 100.0%	36	(3) 100.0%	36	(4) 100.0%	24	(3) 100.0%

Table ST10 Most Used Glenoid Prostheses in Primary Total Resurfacing Shoulder Replacement

2008		2009		2010		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
5	SMR	5	Epoca	7	Global	30	Global	31	Global	27	Global	17	Global
4	Aequalis	3	SMR	5	SMR	3	SMR	4	Aequalis	5	Aequalis	6	Aequalis
2	Copeland	2	Bio-Modular	2	Epoca	1	Epoca	1	SMR	3	Epoca	1	Epoca
1	Global	1	Aequalis	1	Aequalis					1	SMR		
Most Used													
12	(4) 100.0%	11	(4) 100.0%	15	(4) 100.0%	34	(3) 100.0%	36	(3) 100.0%	36	(4) 100.0%	24	(3) 100.0%

Table ST11 Primary Total Resurfacing Shoulder Replacement by Reason for Revision

Reason for Revision	Number	Percent
Instability/Dislocation	2	20.0
Infection	2	20.0
Implant Breakage Glenoid Insert	2	20.0
Loosening/Lysis	1	10.0
Fracture	1	10.0
Implant Breakage Glenoid	1	10.0
Rotator Cuff Insufficiency	1	10.0
TOTAL	10	100.0

Table ST12 Primary Total Resurfacing Shoulder Replacement by Type of Revision

Type of Revision	Number	Percent
Humeral Component	4	40.0
Insert Only	2	20.0
Humeral/Glenoid	2	20.0
Cement Spacer	1	10.0
Head Only	1	10.0
TOTAL	10	100.0

Note: Humeral heads are usually replaced when the humeral component is revised.

Primary Total Mid Head Shoulder Replacement

Demographics and Outcome

There have been 290 primary total mid head shoulder replacements reported to the Registry, an additional 117 procedures compared to the previous report.

Primary total mid head shoulder replacement is undertaken more often in females (57.2%). The median age is 70 years for females and 68 years for males (Table ST13 and Figure ST6).

Osteoarthritis is the principal diagnosis (96.9%) (Table ST14).

There have been three revisions of primary total mid head shoulder replacement. Two were revised for loosening lysis, one to a stemmed hemi and the other had the prostheses removed. The third was revised to a reverse shoulder due to instability/dislocation.

The Simpliciti was the most used humeral component and the Aequalis the most used glenoid component in mid head shoulder replacement in 2014 (Table ST15 and Table ST16).

Table ST13 Primary Total Mid Head Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	166	57.2%	46	87	70	70.1	7.8
Male	124	42.8%	40	89	68	67.0	9.4
TOTAL	290	100.0%	40	89	69	68.7	8.6

Figure ST6 Primary Total Mid Head Shoulder Replacement by Age and Gender

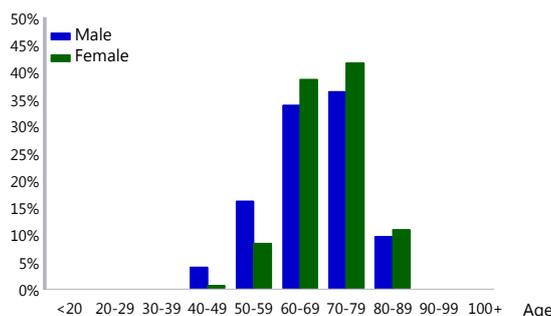


Table ST14 Primary Total Mid Head Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	121	97.6	160	96.4	281	96.9
Osteonecrosis	1	0.8	2	1.2	3	1.0
Rheumatoid Arthritis	1	0.8	2	1.2	3	1.0
Other Inflammatory Arthritis	.	.	1	0.6	1	0.3
Rotator Cuff Arthropathy	.	.	1	0.6	1	0.3
Other	1	0.8	.	.	1	0.3
TOTAL	124	100.0	166	100.0	290	100.0

Table ST15 Most Used Humeral Component Prostheses in Primary Total Mid Head Shoulder Replacement

2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model
2	Simpliciti	46	Affinis	59	Affinis	58	Simpliciti
2	TESS	25	Simpliciti	36	Simpliciti	47	Affinis
1	Affinis			3	Sidus	10	Sidus
Most Used							
5	(3) 100.0%	71	(2) 100.0%	98	(3) 100.0%	115	(3) 100.0%

Table ST16 Most Used Glenoid Prostheses in Primary Total Mid Head Shoulder Replacement

2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model
2	Aequalis	46	Affinis	59	Affinis	58	Aequalis
1	Affinis	25	Aequalis	36	Aequalis	47	Affinis
1	Comprehensive			2	Bigliani/Flatow TM	6	Bigliani/Flatow TM
1	TESS			1	Bigliani/Flatow	2	Anatomical Shoulder
						2	Bigliani/Flatow
Most Used							
5	(4) 100.0%	71	(2) 100.0%	98	(4) 100.0%	115	(5) 100.0%

Primary Total Conventional Shoulder Replacement

Demographics

There have been 8,906 total conventional shoulder replacements reported to the Registry, an additional 1,346 procedures compared to the previous report.

The use of total conventional shoulder replacement has declined from 55.9% of all total shoulder replacements in 2008 to 35.9% in 2014 (Figure ST2).

Osteoarthritis is the principal diagnosis, accounting for 93.8% of procedures (Table ST17).

This procedure is most commonly undertaken in females (58.9%). The proportion of males has increased from 38.7% in 2008 to 43.1% in 2014 (Table ST18 and Figure ST7).

The median age for females is 71 years and 68 years for males (Table ST18). In 2014, most procedures were undertaken in the 65 to 74 year age group, which accounted for 46.4% of all patients (Figure ST8).

The majority of procedures used hybrid fixation (cementless humeral and cemented glenoid) (67.8% in 2014). In 2008, cementless fixation was used in 28.8% of all procedures and its use peaked in 2011 at 33.7%. In 2014, cementless fixation declined to 25.8% of all procedures (Figure ST9).

The 10 most used humeral stem and glenoid prostheses are listed in Table ST19 and Table ST20. The Global AP, SMR and Aequalis Ascend were the most commonly used humeral stem prostheses in 2014. The 10 most used humeral stem prostheses accounted for 98.2% of all primary total conventional shoulder procedures. The Global, Aequalis and SMR were the most commonly used glenoid prostheses in 2014. The 10 most used glenoid prostheses accounted for 98.9% of all primary total conventional shoulder replacements.

Figure ST7 Proportion of Primary Total Conventional Shoulders by Gender

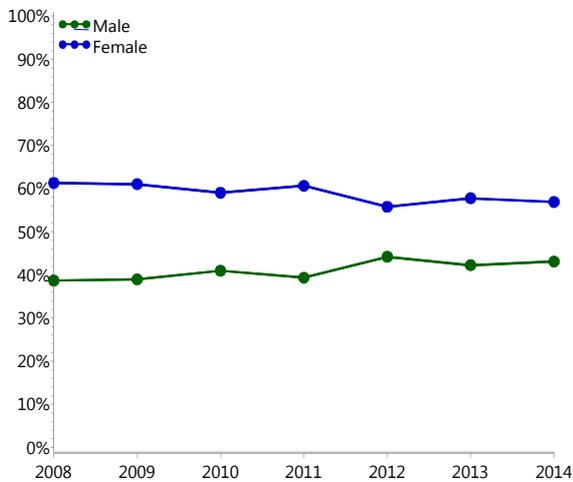


Figure ST8 Proportion of Primary Total Conventional Shoulders by Age

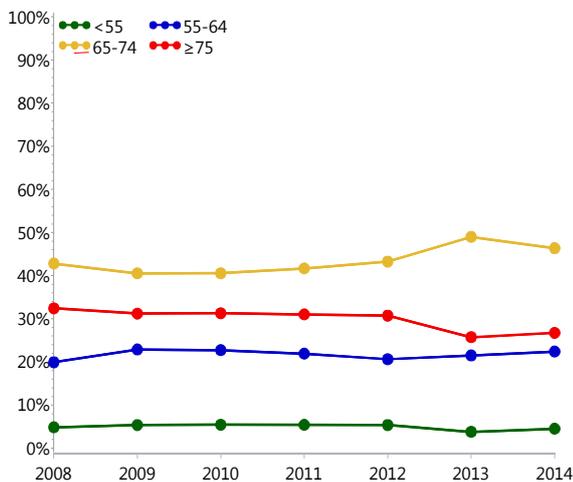


Figure ST9 Proportion of Primary Total Conventional Shoulders by Fixation

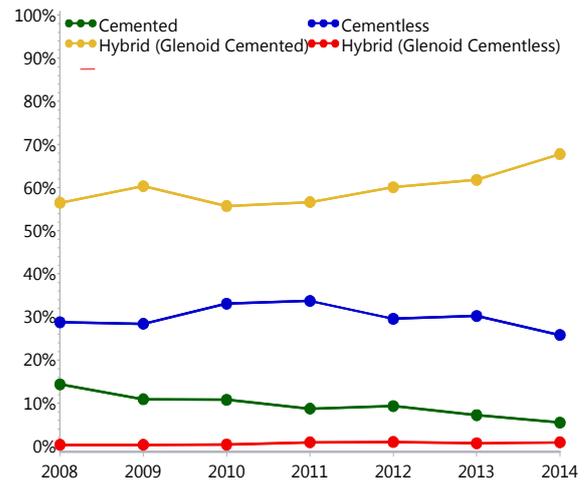


Table ST17 Primary Total Conventional Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	3488	95.4	4867	92.7	8355	93.8
Rheumatoid Arthritis	50	1.4	138	2.6	188	2.1
Osteonecrosis	30	0.8	103	2.0	133	1.5
Fracture	21	0.6	72	1.4	93	1.0
Other Inflammatory Arthritis	20	0.5	29	0.6	49	0.6
Rotator Cuff Arthropathy	27	0.7	18	0.3	45	0.5
Dislocation	3	0.1	11	0.2	14	0.2
Instability	9	0.2	3	0.1	12	0.1
Tumour	4	0.1	5	0.1	9	0.1
Other	5	0.1	3	0.1	8	0.1
TOTAL	3657	100.0	5249	100.0	8906	100.0

Table ST18 Primary Total Conventional Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	5249	58.9%	23	96	71	71.0	8.6
Male	3657	41.1%	26	93	68	67.4	8.9
TOTAL	8906	100.0%	23	96	70	69.5	8.9

Table ST19 10 Most Used Humeral Stem Prostheses in Primary Total Conventional Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
298	SMR	406	SMR	380	Global AP	369	Global AP	385	Global AP
167	Aequalis	302	Global AP	338	SMR	330	SMR	284	SMR
117	Global Advantage	260	Aequalis	235	Aequalis	189	Aequalis	144	Aequalis Ascend
91	Global AP	142	Bigliani/Flatow TM	114	Bigliani/Flatow TM	118	Bigliani/Flatow TM	141	Aequalis
40	Bigliani/Flatow	44	Affinis	54	Ascend	102	Ascend	131	Bigliani/Flatow TM
37	Bigliani/Flatow TM	41	Global Advantage	40	Global Advantage	51	Global Advantage	77	Global Advantage
32	Solar	19	Solar	29	Solar	25	Equinox	44	Comprehensive
27	Affinis	17	Vaios	22	Comprehensive	20	Comprehensive	32	Equinox
11	Univers 3D	13	Comprehensive	17	Vaios	13	Solar	26	Turon
10	Cofield 2	12	Ascend	15	Affinis	7	Turon	21	Ascend
10 Most Used									
830 (10)	97.9%	1256 (10)	96.9%	1244 (10)	96.8%	1224 (10)	98.5%	1285 (10)	98.2%
Remainder									
18 (7)	2.1%	40 (9)	3.1%	41 (6)	3.2%	19 (8)	1.5%	24 (9)	1.8%
TOTAL									
848 (17)	100.0%	1296 (19)	100.0%	1285 (16)	100.0%	1243 (18)	100.0%	1309 (19)	100.0%

Table ST20 10 Most Used Glenoid Prostheses in Primary Total Conventional Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
294	SMR	407	SMR	425	Global	407	Global	438	Global
209	Global	344	Global	338	SMR	330	SMR	304	Aequalis
167	Aequalis	273	Aequalis	289	Aequalis	291	Aequalis	279	SMR
79	Bigliani/Flatow	92	Bigliani/Flatow TM	82	Bigliani/Flatow TM	81	Bigliani/Flatow TM	93	Bigliani/Flatow TM
32	Solar	58	Bigliani/Flatow	40	Bigliani/Flatow	38	Bigliani/Flatow	44	Bigliani/Flatow
27	Affinis	44	Affinis	29	Solar	25	Equinox	44	Comprehensive
11	Univers 3D	19	Solar	22	Comprehensive	20	Comprehensive	32	Equinox
10	Cofield 2	16	Vaios	17	Vaios	15	Global Advantage	27	Global Advantage
7	Promos	12	Comprehensive	15	Affinis	13	Solar	26	Turon
4	Epoca	11	Epoca	10	Equinox	7	Turon	7	Anatomical Shoulder
10 Most Used									
840 (10)	99.1%	1276 (10)	98.5%	1267 (10)	98.6%	1227 (10)	98.7%	1294 (10)	98.9%
Remainder									
8 (5)	0.9%	20 (7)	1.5%	18 (4)	1.4%	16 (5)	1.3%	15 (6)	1.1%
TOTAL									
848 (15)	100.0%	1296 (17)	100.0%	1285 (14)	100.0%	1243 (15)	100.0%	1309 (16)	100.0%

Outcome for All Diagnoses

Primary Diagnosis

The cumulative percent revision of total conventional shoulder replacement for osteoarthritis is 10.5% at eight years. There is no difference in the rate of revision when osteoarthritis is compared to fracture, osteonecrosis and rheumatoid arthritis (Table ST21, Table ST22 and Figure ST10).

Reason for Revision

Instability/dislocation is the most common reason for revision of primary total conventional shoulder replacement. This accounts for 26.4% of all revisions, followed by rotator cuff insufficiency (20.7%) and loosening/lysis (16.5%) (Table ST23). The cumulative incidence of the five most common reasons for revision is presented in Figure ST11.

Type of Revision

The main type of revision is revision of the humeral component only (55.6%). This may include the revision of a humeral component (epiphysis and/or humeral stem) and additional minor components (Table ST24). Of the 306 humeral component revisions, 262 (85.6%) were revised to a total reverse shoulder replacement. The stem was not revised in 250 (95.4%) procedures.

Table ST21 Revision Rates of Primary Total Conventional Shoulder Replacement by Primary Diagnosis

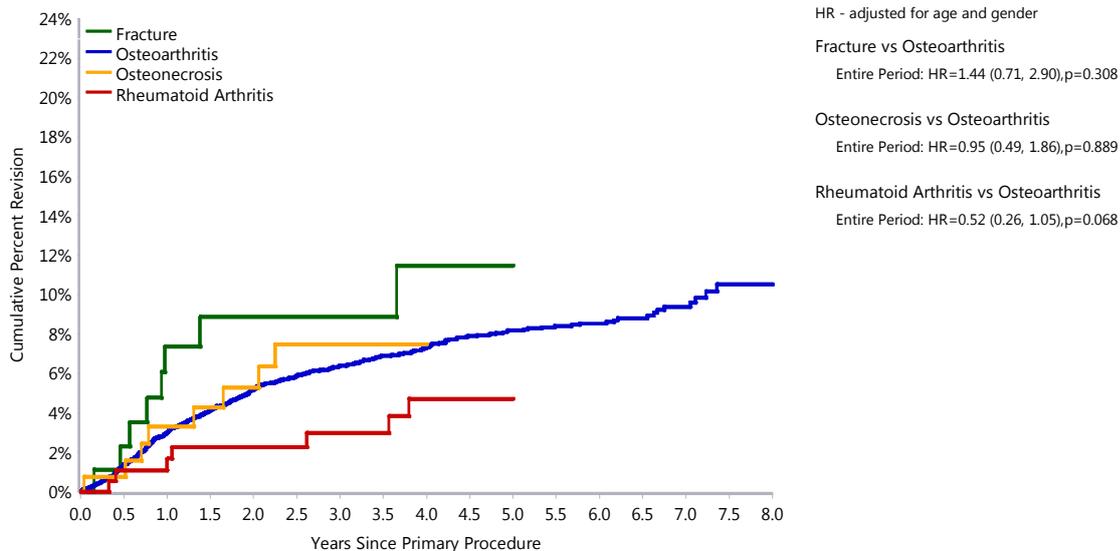
Primary Diagnosis	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Osteoarthritis	512	8355	27333	1.87 (1.71, 2.04)
Rheumatoid Arthritis	8	188	742	1.08 (0.47, 2.12)
Osteonecrosis	9	133	428	2.10 (0.96, 3.99)
Fracture	8	93	278	2.87 (1.24, 5.66)
Other Inflammatory Arthritis	2	49	181	1.11 (0.13, 4.00)
Rotator Cuff Arthropathy	6	45	133	4.51 (1.65, 9.81)
Other (4)	5	43	131	3.82 (1.24, 8.91)
TOTAL	550	8906	29226	1.88 (1.73, 2.05)

Note: Only primary diagnoses with over 50 procedures have been listed.

Table ST22 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Primary Diagnosis

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Osteoarthritis	3.0 (2.7, 3.4)	5.2 (4.7, 5.8)	6.4 (5.8, 7.0)	8.2 (7.5, 9.0)	8.5 (7.8, 9.4)	9.4 (8.4, 10.5)	10.5 (9.1, 12.1)
Rheumatoid Arthritis	1.7 (0.5, 5.1)	2.3 (0.9, 5.9)	3.0 (1.2, 7.1)	4.7 (2.2, 9.8)			
Osteonecrosis	3.3 (1.3, 8.6)	5.3 (2.4, 11.4)	7.5 (3.8, 14.5)				
Fracture	7.4 (3.4, 15.7)	8.9 (4.3, 17.8)	8.9 (4.3, 17.8)	11.5 (5.7, 22.4)			
Other Inflammatory Arthritis	0.0 (0.0, 0.0)	2.5 (0.4, 16.5)	2.5 (0.4, 16.5)	6.0 (1.5, 22.3)	6.0 (1.5, 22.3)		
Rotator Cuff Arthropathy	6.9 (2.3, 20.0)	12.9 (5.5, 28.8)	17.3 (7.9, 35.6)	17.3 (7.9, 35.6)			
Other (4)	5.1 (1.3, 18.9)	8.3 (2.7, 23.7)	15.5 (6.6, 33.7)	15.5 (6.6, 33.7)			

Figure ST10 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Primary Diagnosis



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Fracture	93	70	55	43	20	9	3	1
Osteoarthritis	8355	6830	5477	4242	2035	1103	417	71
Osteonecrosis	133	104	90	65	35	18	6	1
Rheumatoid Arthritis	188	169	149	127	61	28	9	2

Table ST23 Primary Total Conventional Shoulder Replacement by Reason for Revision

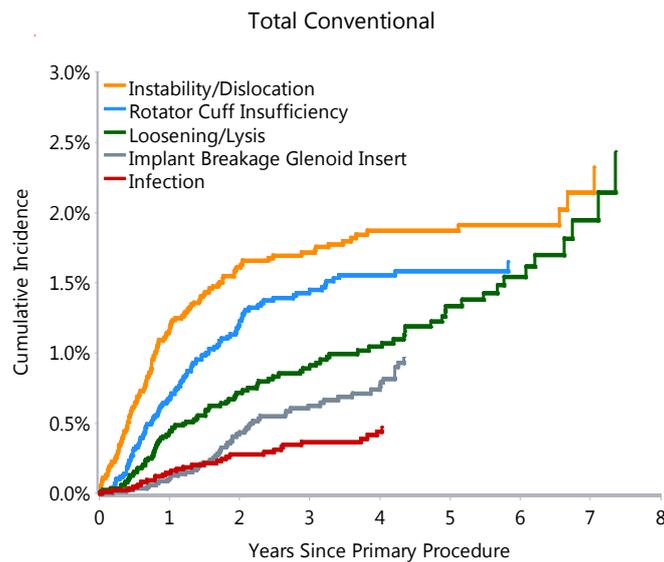
Reason for Revision	Number	Percent
Instability/Dislocation	145	26.4
Rotator Cuff Insufficiency	114	20.7
Loosening/Lysis	91	16.5
Implant Breakage Glenoid Insert	55	10.0
Infection	30	5.5
Dissociation	25	4.5
Implant Breakage Glenoid	17	3.1
Incorrect Sizing	13	2.4
Arthrofibrosis	12	2.2
Pain	11	2.0
Fracture	10	1.8
Metal Related Pathology	6	1.1
Malposition	5	0.9
Wear Glenoid Insert	2	0.4
Wear Glenoid	1	0.2
Other	13	2.4
TOTAL	550	100.0

Table ST24 Primary Total Conventional Shoulder Replacement by Type of Revision

Type of Revision	Number	Percent
Humeral Component	306	55.6
Humeral/Glenoid	76	13.8
Head Only	62	11.3
Glenoid Component	48	8.7
Head/Insert	30	5.5
Cement Spacer	13	2.4
Removal of Prostheses	8	1.5
Reoperation	3	0.5
Minor Components	3	0.5
Reinsertion of Components	1	0.2
TOTAL	550	100.0

Note: Humeral heads are usually replaced when the humeral component is revised.

Figure ST11 Cumulative Incidence Revision Diagnosis of Primary Total Conventional Shoulder Replacement



Outcome for Osteoarthritis

Age and Gender

There is no difference in the rate of revision between those aged less than 55 years compared to 55 to 64 and 65 to 74 years. Patients aged 75 years and older have a lower revision rate compared to those aged less than 55 years (Table ST25, Table ST26 and Figure ST12). There is no difference in the rate of revision between males and females (Table ST27, Table ST28 and Figure ST13).

Fixation

Cementless fixation has a higher rate of revision compared to both cemented and hybrid fixation (glenoid cemented). There is no difference between cemented and hybrid fixation (glenoid cemented) (Table ST29, Table ST30 and Figure ST14).

The fixation analysis was repeated excluding the SMR prosthesis because it has a higher than anticipated rate of revision. It is predominately used with cementless fixation and accounts for a high proportion of the procedures. The outcome of fixation remained the same with cementless fixation of the glenoid being associated with a higher rate of revision (Table ST31, Table ST32 and Figure ST15).

Glenoid Type and Design

Further analysis was undertaken looking at the type and design of the glenoid used. An all polyethylene glenoid was used in 69.6% of total conventional shoulder replacements. This has a lower rate of revision

compared to metal backed glenoids with modular or fixed inserts. A glenoid with a modular insert has a higher rate of revision compared to a glenoid with a fixed insert (Table ST33, Table ST34 and Figure ST16).

The cumulative percent revision at three years is 15.8% for metal backed glenoids with modular inserts compared to 3.0% for all polyethylene glenoid and 4.4% for metal backed glenoids with a fixed insert.

Of the revisions for the metal backed glenoid with modular insert, 88.7% retained the glenoid component and replaced the modular polyethylene with a glenosphere. Of these, 12 of the 250 procedures also revised the humeral stem.

The above analysis was repeated excluding the SMR and the results remain consistent (Table ST35, Table ST36 and Figure ST17).

A pegged cemented glenoid was used in 86.2% of all total conventional shoulder replacements with polyethylene glenoids. There is no difference in the rate of revision between pegged and keeled all polyethylene glenoids (Table ST37, Table ST38 and Figure ST18).

The outcomes of the most commonly used prostheses are listed in Table ST39 and Table ST40.

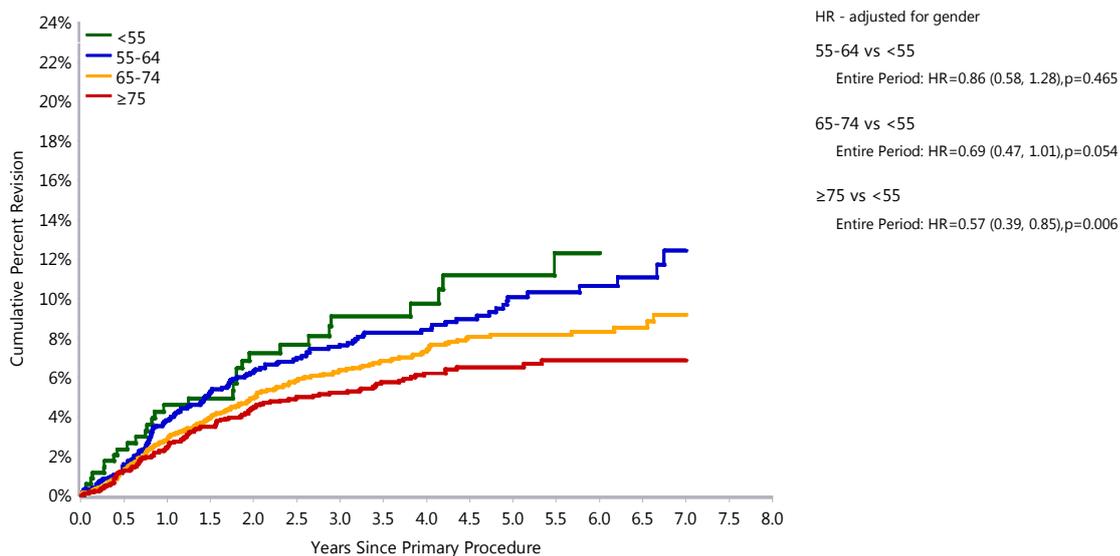
Table ST25 Revision Rates of Primary Total Conventional Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	31	350	1175	2.64 (1.79, 3.74)
55-64	135	1793	5890	2.29 (1.92, 2.71)
65-74	216	3656	11713	1.84 (1.61, 2.11)
≥75	130	2556	8555	1.52 (1.27, 1.80)
TOTAL	512	8355	27333	1.87 (1.71, 2.04)

Table ST26 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Age (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	4.6 (2.8, 7.5)	7.2 (4.8, 10.8)	9.1 (6.2, 13.1)	11.2 (7.7, 16.0)	12.3 (8.4, 17.7)		
55-64	3.8 (3.0, 4.9)	6.3 (5.2, 7.7)	7.6 (6.4, 9.1)	10.1 (8.4, 12.0)	10.6 (8.9, 12.7)	12.4 (9.9, 15.5)	
65-74	2.9 (2.4, 3.5)	5.0 (4.3, 5.8)	6.4 (5.5, 7.3)	8.2 (7.1, 9.4)	8.3 (7.2, 9.5)	9.2 (7.8, 10.8)	
≥75	2.5 (1.9, 3.2)	4.5 (3.7, 5.4)	5.2 (4.3, 6.3)	6.5 (5.5, 7.8)	6.9 (5.7, 8.2)	6.9 (5.7, 8.2)	

Figure ST12 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Age (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	350	285	238	180	94	53	19	2
55-64	1793	1454	1175	930	449	233	97	16
65-74	3656	2970	2324	1784	863	477	170	31
≥75	2556	2121	1740	1348	629	340	131	22

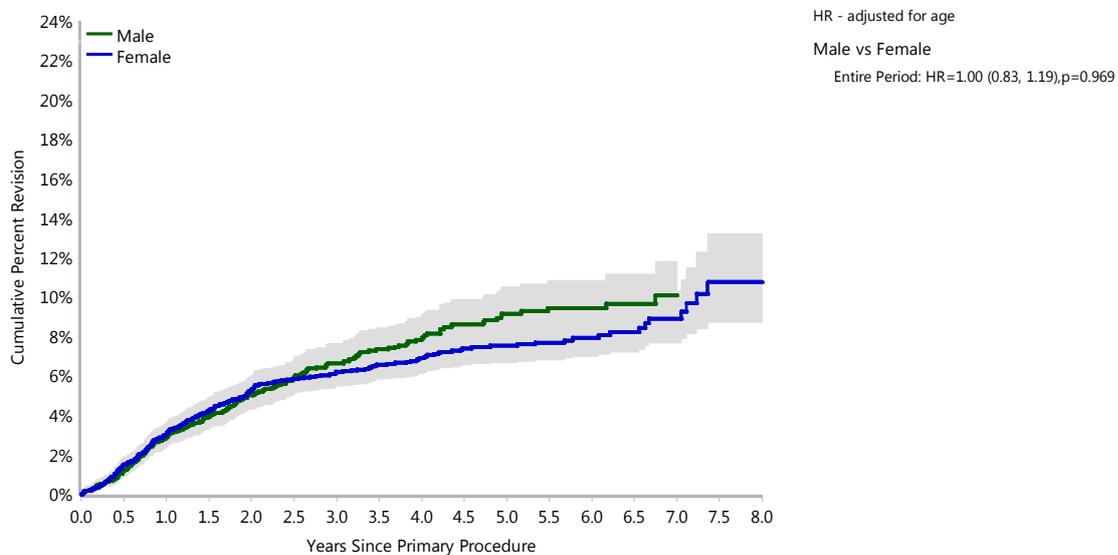
Table ST27 Revision Rates of Primary Total Conventional Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	221	3488	11109	1.99 (1.74, 2.27)
Female	291	4867	16224	1.79 (1.59, 2.01)
TOTAL	512	8355	27333	1.87 (1.71, 2.04)

Table ST28 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Gender (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	2.9 (2.4, 3.6)	5.0 (4.3, 5.9)	6.7 (5.8, 7.7)	9.2 (8.0, 10.5)	9.5 (8.2, 10.9)	10.1 (8.6, 11.8)	
Female	3.1 (2.6, 3.7)	5.3 (4.7, 6.1)	6.2 (5.5, 7.0)	7.5 (6.7, 8.5)	7.9 (7.0, 9.0)	8.9 (7.7, 10.3)	10.8 (8.7, 13.2)

Figure ST13 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Gender (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	3488	2826	2251	1691	796	429	166	29
Female	4867	4004	3226	2551	1239	674	251	42

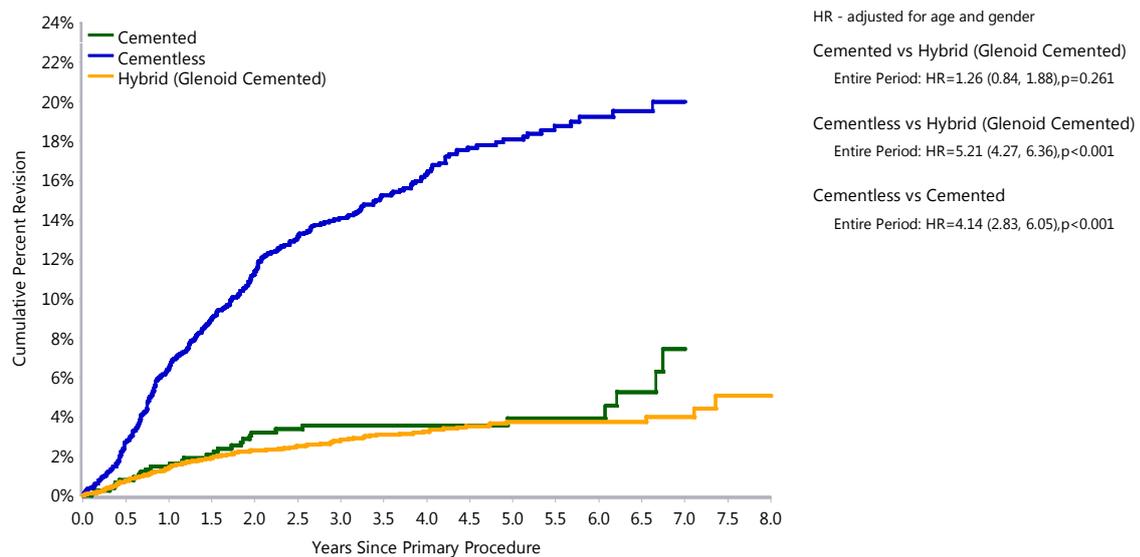
Table ST29 Revision Rates of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	29	763	2987	0.97 (0.65, 1.39)
Cementless	342	2504	7814	4.38 (3.93, 4.87)
Hybrid (Glenoid Cemented)	135	5040	16405	0.82 (0.69, 0.97)
Hybrid (Glenoid Cementless)	6	48	127	4.72 (1.73, 10.28)
TOTAL	512	8355	27333	1.87 (1.71, 2.04)

Table ST30 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cemented	1.5 (0.8, 2.7)	3.2 (2.1, 4.8)	3.6 (2.4, 5.3)	3.9 (2.6, 5.8)	3.9 (2.6, 5.8)	7.4 (4.4, 12.3)	
Cementless	6.5 (5.6, 7.6)	11.4 (10.1, 12.8)	14.1 (12.6, 15.7)	18.1 (16.3, 20.0)	19.2 (17.2, 21.4)	20.0 (17.8, 22.4)	
Hybrid (Glenoid Cemented)	1.4 (1.1, 1.8)	2.3 (1.9, 2.8)	2.9 (2.4, 3.4)	3.8 (3.1, 4.5)	3.8 (3.1, 4.5)	4.0 (3.2, 4.9)	5.1 (3.6, 7.1)
Hybrid (Glenoid Cementless)	11.2 (4.8, 25.0)	11.2 (4.8, 25.0)	11.2 (4.8, 25.0)				

Figure ST14 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cemented	763	682	584	479	262	158	57	7
Cementless	2504	2019	1572	1200	552	295	111	19
Hybrid (Glenoid Cemented)	5040	4093	3292	2543	1216	647	246	45

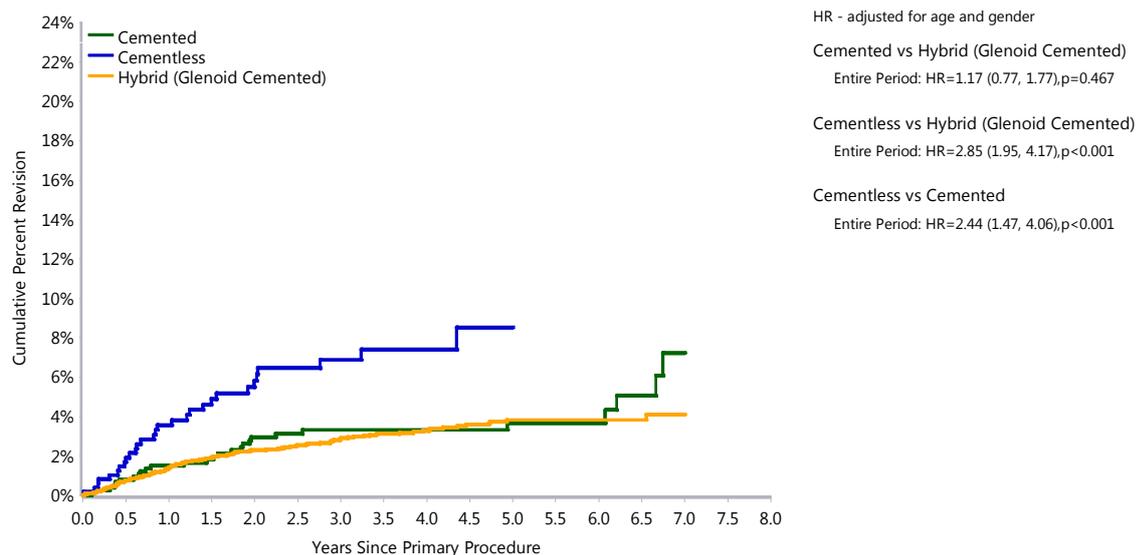
Table ST31 Revision Rates of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	27	750	2943	0.92 (0.60, 1.33)
Cementless	34	500	1299	2.62 (1.81, 3.66)
Hybrid (Glenoid Cemented)	127	4716	15138	0.84 (0.70, 1.00)
Hybrid (Glenoid Cementless)	2	16	38	5.25 (0.64, 18.97)
TOTAL	190	5982	19418	0.98 (0.84, 1.13)

Table ST32 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cemented	1.5 (0.8, 2.7)	3.0 (1.9, 4.6)	3.3 (2.2, 5.0)	3.7 (2.4, 5.6)	3.7 (2.4, 5.6)	7.2 (4.3, 12.2)	
Cementless	3.6 (2.2, 5.8)	5.8 (3.9, 8.6)	6.9 (4.7, 10.0)	8.5 (5.6, 12.8)			
Hybrid (Glenoid Cemented)	1.4 (1.1, 1.8)	2.3 (1.9, 2.8)	2.9 (2.4, 3.5)	3.8 (3.2, 4.6)	3.8 (3.2, 4.6)	4.1 (3.3, 5.1)	
Hybrid (Glenoid Cementless)	13.5 (3.5, 44.2)	13.5 (3.5, 44.2)	13.5 (3.5, 44.2)				

Figure ST15 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cemented	750	670	575	471	259	156	57	7
Cementless	500	385	294	198	49	19	11	4
Hybrid (Glenoid Cemented)	4716	3802	3041	2334	1112	569	220	37

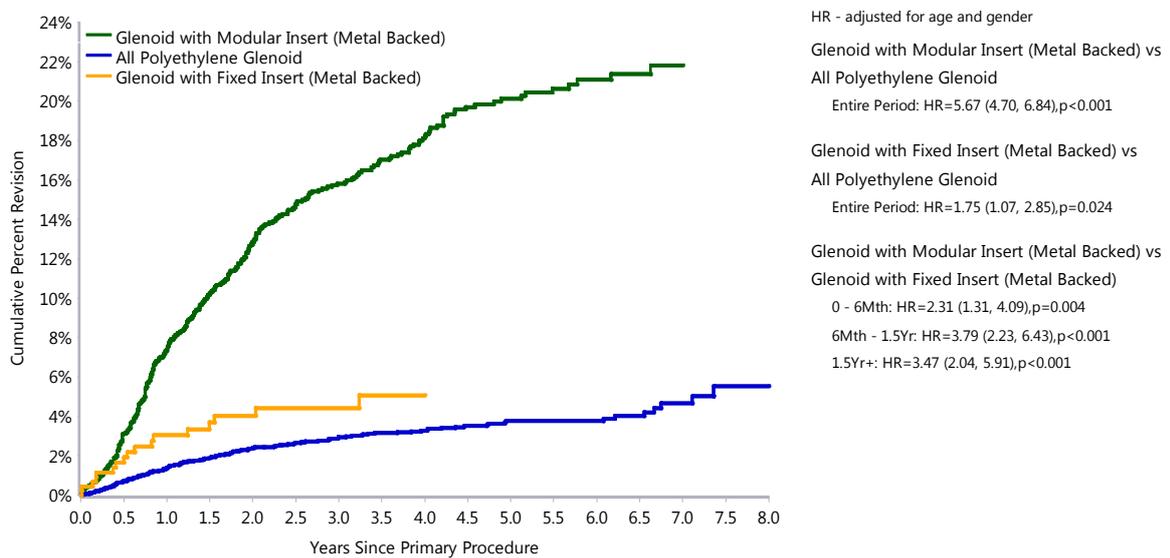
Table ST33 Revision Rates of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA)

Glenoid Type	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Glenoid Modular Insert (Metal Backed)	330	2095	6841	4.82 (4.32, 5.37)
All Polyethylene Glenoid	164	5817	19445	0.84 (0.72, 0.98)
Glenoid Fixed Insert (Metal Backed)	18	443	1047	1.72 (1.02, 2.72)
TOTAL	512	8355	27333	1.87 (1.71, 2.04)

Table ST34 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Glenoid Modular Insert (Metal Backed)	7.4 (6.4, 8.7)	12.9 (11.4, 14.5)	15.8 (14.2, 17.6)	20.1 (18.1, 22.3)	21.1 (19.0, 23.4)	21.8 (19.5, 24.4)	
All Polyethylene Glenoid	1.4 (1.1, 1.8)	2.4 (2.0, 2.9)	3.0 (2.5, 3.5)	3.8 (3.2, 4.4)	3.8 (3.2, 4.4)	4.7 (3.8, 5.8)	5.5 (4.2, 7.4)
Glenoid Fixed Insert (Metal Backed)	3.0 (1.7, 5.3)	4.0 (2.4, 6.7)	4.4 (2.7, 7.2)				

Figure ST16 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Glenoid Modular Insert (Metal Backed)	2095	1708	1342	1048	530	298	114	19
All Polyethylene Glenoid	5817	4797	3892	3030	1477	805	303	52
Glenoid Fixed Insert (Metal Backed)	443	325	243	164	28	0	0	0

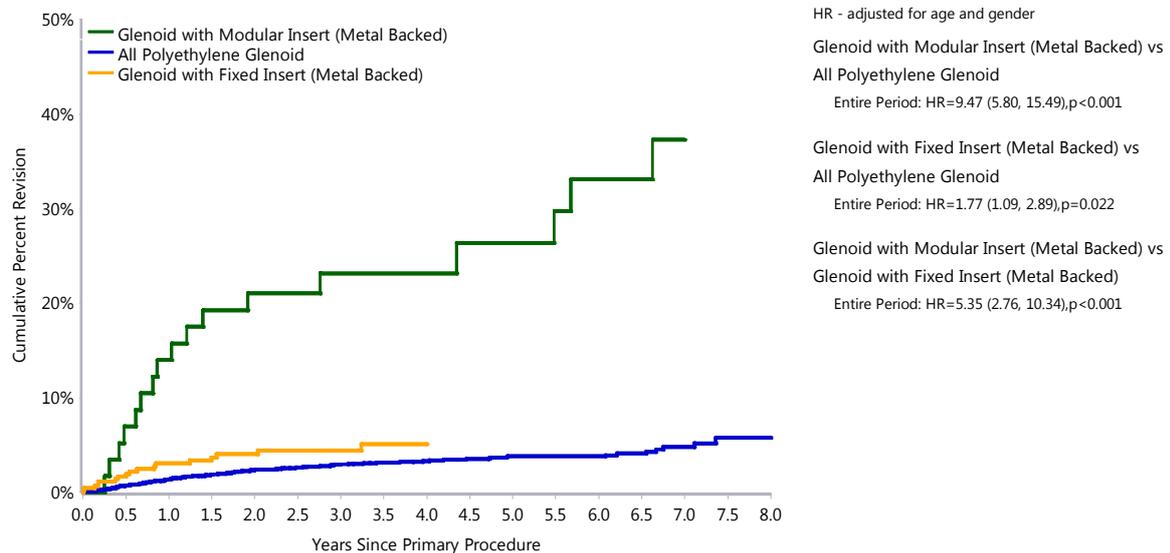
Table ST35 Revision Rates of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA, excluding SMR)

Glenoid Type	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Glenoid Modular Insert (Metal Backed)	18	58	235	7.67 (4.55, 12.13)
All Polyethylene Glenoid	154	5481	18137	0.85 (0.72, 0.99)
Glenoid Fixed Insert (Metal Backed)	18	443	1047	1.72 (1.02, 2.72)
TOTAL	190	5982	19418	0.98 (0.84, 1.13)

Table ST36 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA, excluding SMR)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Glenoid Modular Insert (Metal Backed)	14.0 (7.2, 26.0)	21.0 (12.5, 34.1)	23.2 (14.1, 36.6)	26.4 (16.3, 41.0)	33.1 (21.1, 49.4)	37.3 (24.0, 54.7)	
All Polyethylene Glenoid	1.4 (1.1, 1.8)	2.4 (2.0, 2.9)	3.0 (2.5, 3.5)	3.8 (3.2, 4.5)	3.8 (3.2, 4.5)	4.8 (3.8, 6.0)	5.8 (4.3, 7.8)
Glenoid Fixed Insert (Metal Backed)	3.0 (1.7, 5.3)	4.0 (2.4, 6.7)	4.4 (2.7, 7.2)				

Figure ST17 Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA, excluding SMR)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Glenoid Modular Insert (Metal Backed)	58	49	44	32	23	19	11	4
All Polyethylene Glenoid	5481	4495	3632	2813	1370	725	277	44
Glenoid Fixed Insert (Metal Backed)	443	325	243	164	28	0	0	0

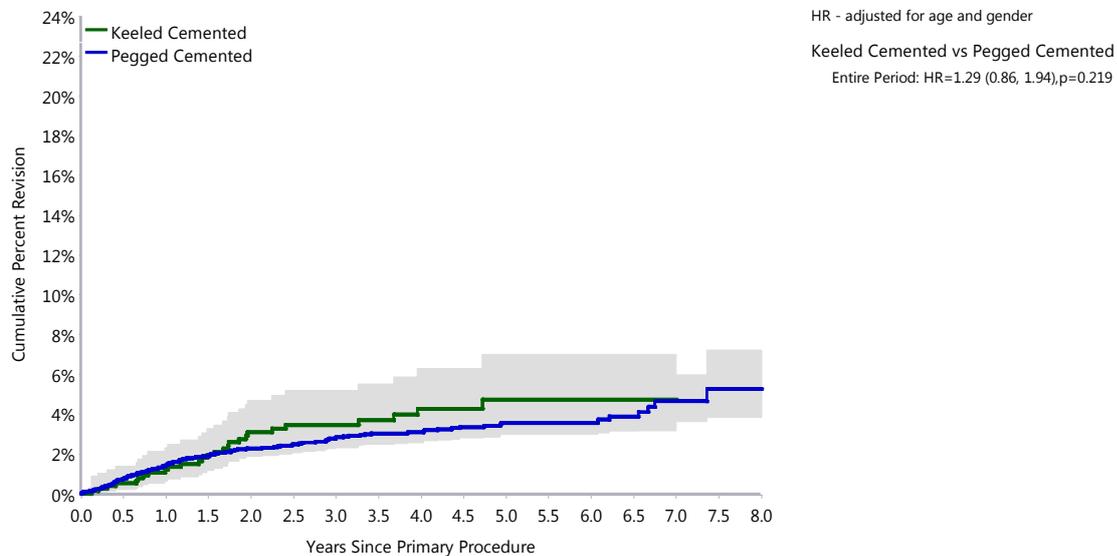
Table ST37 Revision Rates of All Polyethylene Primary Total Conventional Shoulder Replacement by Glenoid Design and Fixation (Primary Diagnosis OA)

Glenoid Design and Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Keeled Cemented	28	797	2763	1.01 (0.67, 1.46)
Pegged Cemented	134	4986	16592	0.81 (0.68, 0.96)
TOTAL	162	5783	19355	0.84 (0.71, 0.98)

Table ST38 Yearly Cumulative Percent Revision of All Polyethylene Primary Total Conventional Shoulder Replacement by Glenoid Design and Fixation (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Keeled Cemented	1.2 (0.6, 2.3)	3.1 (2.0, 4.7)	3.5 (2.3, 5.2)	4.7 (3.2, 7.0)	4.7 (3.2, 7.0)	4.7 (3.2, 7.0)	
Pegged Cemented	1.4 (1.1, 1.8)	2.3 (1.9, 2.8)	2.8 (2.4, 3.4)	3.6 (3.0, 4.3)	3.6 (3.0, 4.3)	4.6 (3.6, 6.0)	5.3 (3.8, 7.2)

Figure ST18 Cumulative Percent Revision of All Polyethylene Primary Total Conventional Shoulder Replacement by Glenoid Design and Fixation (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Keeled Cemented	797	693	558	438	190	116	51	2
Pegged Cemented	4986	4074	3311	2578	1285	688	252	50

Table ST39 Revision Rates of Primary Total Conventional Shoulder Replacement by Humeral Stem and Glenoid (Primary Diagnosis OA)

Humeral Stem	Glenoid	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	36	1437	5096	0.71 (0.49, 0.98)
Aequalis Ascend	Aequalis	0	133	56	0.00 (0.00, 6.59)
Affinis	Affinis	8	168	768	1.04 (0.45, 2.05)
Ascend	Aequalis	2	182	329	0.61 (0.07, 2.19)
Bigliani/Flatow	Bigliani/Flatow	6	140	763	0.79 (0.29, 1.71)
Bigliani/Flatow TM	Bigliani/Flatow	17	304	1075	1.58 (0.92, 2.53)
Bigliani/Flatow TM	Bigliani/Flatow TM	17	418	1010	1.68 (0.98, 2.70)
Comprehensive	Comprehensive	5	98	143	3.50 (1.13, 8.16)
Equinox	Equinox	0	70	91	0.00 (0.00, 4.07)
Global AP	Global	43	1968	5492	0.78 (0.57, 1.05)
Global Advantage	Global	19	525	2549	0.75 (0.45, 1.16)
SMR	SMR	322	2371	7908	4.07 (3.64, 4.54)
Solar	Solar	5	169	767	0.65 (0.21, 1.52)
Other (29)		32	372	1285	2.49 (1.70, 3.51)
TOTAL		512	8355	27333	1.87 (1.71, 2.04)

Note: Only combinations with over 50 procedures have been listed.

Table ST40 Yearly Cumulative Percent Revision of Primary Total Conventional Shoulder Replacement by Humeral Stem and Glenoid (Primary Diagnosis OA)

Humeral Stem	Glenoid	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	Aequalis	1.3 (0.8, 2.1)	2.3 (1.6, 3.3)	2.5 (1.8, 3.5)	3.0 (2.1, 4.2)	3.0 (2.1, 4.2)	3.9 (2.3, 6.7)	
Aequalis Ascend	Aequalis							
Affinis	Affinis	0.0 (0.0, 0.0)	0.6 (0.1, 4.4)	1.9 (0.6, 5.8)	6.4 (3.0, 13.4)			
Ascend	Aequalis	0.0 (0.0, 0.0)	2.6 (0.7, 10.3)					
Bigliani/Flatow	Bigliani/Flatow	2.2 (0.7, 6.6)	2.2 (0.7, 6.6)	3.7 (1.6, 8.7)	3.7 (1.6, 8.7)	3.7 (1.6, 8.7)		
Bigliani/Flatow TM	Bigliani/Flatow	2.5 (1.2, 5.1)	5.0 (2.9, 8.4)	5.4 (3.2, 9.1)	7.2 (4.5, 11.6)	7.2 (4.5, 11.6)		
Bigliani/Flatow TM	Bigliani/Flatow TM	2.9 (1.6, 5.1)	3.9 (2.3, 6.5)	4.3 (2.6, 7.1)				
Comprehensive	Comprehensive	6.2 (2.6, 14.3)	6.2 (2.6, 14.3)	6.2 (2.6, 14.3)				
Equinox	Equinox	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)					
Global AP	Global	1.5 (1.0, 2.2)	2.3 (1.7, 3.1)	2.6 (1.9, 3.5)	2.9 (2.1, 3.9)	2.9 (2.1, 3.9)		
Global Advantage	Global	1.4 (0.7, 2.9)	2.7 (1.6, 4.6)	3.4 (2.1, 5.6)	3.4 (2.1, 5.6)	3.4 (2.1, 5.6)	4.9 (3.0, 7.8)	
SMR	SMR	6.4 (5.5, 7.5)	11.2 (9.9, 12.6)	13.7 (12.3, 15.3)	17.5 (15.7, 19.4)	18.0 (16.1, 20.0)	18.2 (16.3, 20.3)	
Solar	Solar	0.6 (0.1, 4.1)	0.6 (0.1, 4.1)	2.0 (0.6, 6.1)	3.2 (1.2, 8.7)	3.2 (1.2, 8.7)		
Other (29)		3.4 (1.9, 6.0)	5.9 (3.8, 9.3)	8.0 (5.4, 11.9)	11.1 (7.6, 15.9)	13.1 (9.0, 18.9)		

Note: Only combinations with over 50 procedures have been listed.

Primary Total Reverse Shoulder Replacement

Demographics

There have been 9,682 total reverse replacements reported to the Registry. This is an increase of 2,266 compared to the previous report. Primary total reverse shoulder replacement has increased from 43.3% of all total shoulder replacements in 2008 to 60.3% in 2014.

The principal diagnoses are osteoarthritis (46.0%), rotator cuff arthropathy (33.6%) and fracture (14.1%) (Table ST41).

The proportion of total reverse shoulder replacements for osteoarthritis declined from 57.8% in 2008 to 40.4% in 2013. This has increased to 45.9% in 2014. Over the same period, the proportion of procedures for rotator cuff arthropathy increased from 21.0% to 38.1% in 2013. This has decreased to 33.5% in 2014 (Figure ST19).

Primary total reverse shoulder replacement is most commonly undertaken in females (66.2%) (Table ST42 and Figure ST20). The median age for females is 77 years and 74 years for males (Figure ST22). The proportion of patients aged 75 years and older has declined from 61.4% in 2010 to 54.7% in 2014 (Figure ST21).

The majority of procedures use cementless fixation (73.1% in 2014). Hybrid fixation (cemented humeral and cementless glenoid) was used in 25.9% of procedures. There has been little variation in the use of fixation since 2008 (Figure ST22).

The most used humeral stems and glenoid prostheses are listed in Table ST43 and Table ST44. The Delta Xtend, SMR and Aequalis remain the three most commonly used prostheses.

Figure ST19 Proportion of Primary Total Reverse Shoulders by Primary Diagnosis

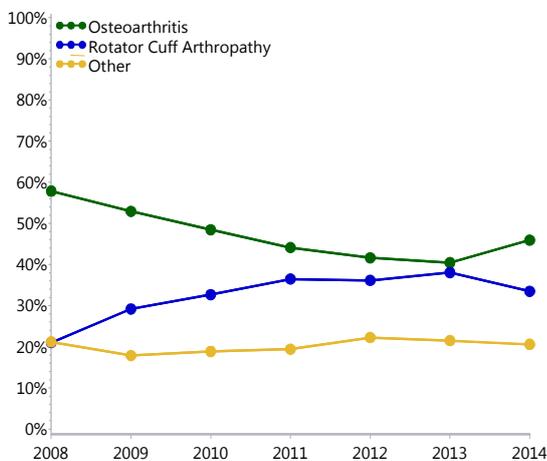


Figure ST21 Proportion of Primary Total Reverse Shoulders by Age

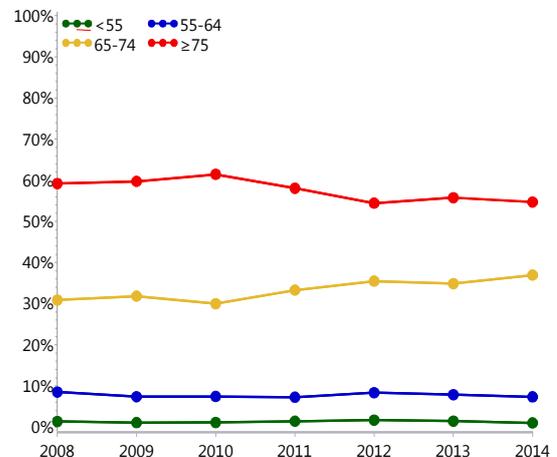


Figure ST20 Proportion of Primary Total Reverse Shoulders by Gender

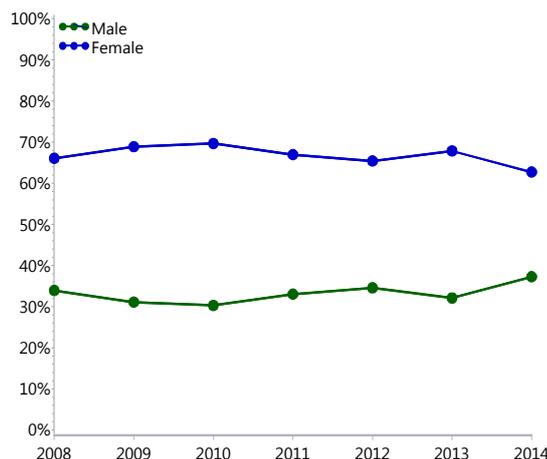


Figure ST22 Proportion of Primary Total Reverse Shoulders by Fixation

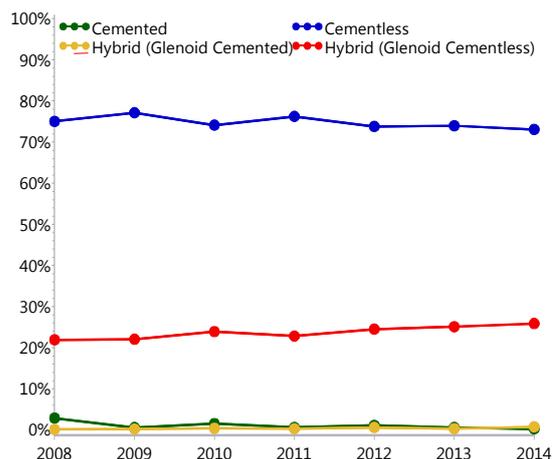


Table ST41 Primary Total Reverse Shoulder Replacement by Primary Diagnosis and Gender

Primary Diagnosis	Male		Female		TOTAL	
	N	Col%	N	Col%	N	Col%
Osteoarthritis	1604	49.0	2849	44.4	4453	46.0
Rotator Cuff Arthropathy	1316	40.2	1934	30.2	3250	33.6
Fracture	196	6.0	1166	18.2	1362	14.1
Rheumatoid Arthritis	47	1.4	195	3.0	242	2.5
Osteonecrosis	13	0.4	91	1.4	104	1.1
Dislocation	22	0.7	78	1.2	100	1.0
Tumour	42	1.3	39	0.6	81	0.8
Instability	21	0.6	32	0.5	53	0.5
Other Inflammatory Arthritis	9	0.3	24	0.4	33	0.3
Other	1	0.0	3	0.0	4	0.0
TOTAL	3271	100.0	6411	100.0	9682	100.0

Table ST42 Primary Total Reverse Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	6411	66.2%	14	102	77	75.9	8.0
Male	3271	33.8%	24	96	74	73.5	8.1
TOTAL	9682	100.0%	14	102	76	75.1	8.1

Table ST43 10 Most Used Humeral Stem Prostheses in Primary Total Reverse Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
262	SMR	484	SMR	553	Delta Xtend	708	Delta Xtend	829	Delta Xtend
252	Delta Xtend	437	Delta Xtend	511	SMR	565	SMR	610	SMR
76	Aequalis	205	Aequalis	294	Aequalis	306	Aequalis	246	Aequalis
42	Trabecular Metal	108	Trabecular Metal	119	Trabecular Metal	142	Trabecular Metal	136	Trabecular Metal
21	Delta CTA	15	Comprehensive	16	Comprehensive	38	RSP	110	RSP
2	Custom Made (Lima)	15	Vaios	12	Vaios	36	Comprehensive	82	Aequalis Ascend
1	Generic Humeral Stem	14	Mets	9	Equinox	14	Equinox	76	Comprehensive
1	Promos	3	Promos	8	Mets	13	Global Unite	45	Global Unite
		1	Equinox	4	Global Unite	12	Affinis	29	Equinox
		1	Generic Humeral Stem	2	Affinis	7	Vaios	14	Anatomical Shoulder
10 Most Used									
657 (8)	100.0%	1283 (10)	100.0%	1528 (10)	99.9%	1841 (10)	99.4%	2177 (10)	99.2%
Remainder									
0 (0)	0%	0 (0)	0%	2 (2)	0.1%	11 (3)	0.6%	18 (3)	0.8%
TOTAL									
657 (8)	100.0%	1283 (10)	100.0%	1530 (12)	100.0%	1852 (13)	100.0%	2195 (13)	100.0%

Table ST44 10 Most Used Glenoid Prostheses in Primary Total Reverse Shoulder Replacement

2008		2011		2012		2013		2014	
N	Model	N	Model	N	Model	N	Model	N	Model
264	SMR	484	SMR	557	Delta Xtend	721	Delta Xtend	874	Delta Xtend
252	Delta Xtend	437	Delta Xtend	510	SMR	560	SMR	604	SMR
76	Aequalis	206	Aequalis	295	Aequalis	311	Aequalis	329	Aequalis
42	Trabecular Metal	108	Trabecular Metal	119	Trabecular Metal	144	Trabecular Metal	144	Trabecular Metal
21	Delta CTA	15	Comprehensive Reverse	16	Comprehensive Reverse	38	RSP	110	RSP
1	Generic Metaglène	15	Vaios	12	Vaios	36	Comprehensive Reverse	75	Comprehensive Reverse
1	Promos	14	Mets	9	Equinoxe	14	Equinoxe	29	Equinoxe
		3	Promos	8	Mets	12	Affinis	10	Affinis
		1	Equinoxe	2	Affinis	7	Vaios	7	Anatomical Shoulder
				1	Mutars	6	Mets	7	Mets
10 Most Used									
657	(7) 100.0%	1283	(9) 100.0%	1529	(10) 99.9%	1849	(10) 99.8%	2189	(10) 99.7%
Remainder									
0	(0) 0%	0	(0) 0%	1	(1) 0.1%	3	(2) 0.2%	6	(3) 0.3%
TOTAL									
657	(7) 100.0%	1283	(9) 100.0%	1530	(11) 100.0%	1852	(12) 100.0%	2195	(13) 100.0%

Outcome for All Diagnoses

Primary Diagnosis

There is no difference in the rate of revision related to primary diagnosis (Table ST45, Table ST46 and Figure ST23).

Reason for Revision

Instability/dislocation is the most common reason for revision (42.2%), followed by loosening/lysis (19.4%), infection (15.2%) and fracture (11.4%) (Table ST47).

Type of Revision

The main types of revision are replacement of both cup (liner) and head (glenosphere) (26.7%), cup only (21.7%), humeral component only (17.9%, which may include the revision of an epiphysis and/or humeral stem and additional minor components) and head only (15.5%) (Table ST48).

Table ST45 Revision Rates of Primary Total Reverse Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Dislocation	3	100	284	1.06 (0.22, 3.08)
Fracture	42	1362	3071	1.37 (0.99, 1.85)
Osteoarthritis	156	4453	12459	1.25 (1.06, 1.46)
Osteonecrosis	2	104	292	0.68 (0.08, 2.47)
Rheumatoid Arthritis	10	242	698	1.43 (0.69, 2.64)
Rotator Cuff Arthropathy	118	3250	7973	1.48 (1.23, 1.77)
Other (4)	10	171	447	2.24 (1.07, 4.12)
TOTAL	341	9682	25223	1.35 (1.21, 1.50)

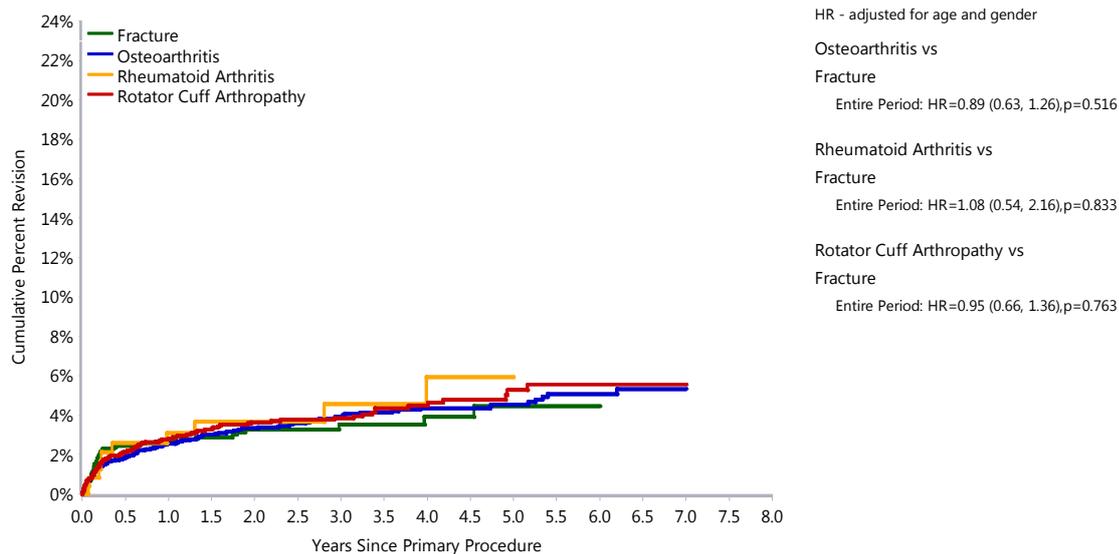
Note: Only Primary Diagnoses with over 100 procedures have been listed.

Table ST46 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Primary Diagnosis

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Dislocation	3.3 (1.1, 10.0)	3.3 (1.1, 10.0)	3.3 (1.1, 10.0)	3.3 (1.1, 10.0)	3.3 (1.1, 10.0)		
Fracture	2.6 (1.9, 3.7)	3.3 (2.4, 4.5)	3.5 (2.6, 4.9)	4.5 (3.0, 6.6)	4.5 (3.0, 6.6)		
Osteoarthritis	2.5 (2.1, 3.1)	3.3 (2.8, 4.0)	3.9 (3.3, 4.6)	4.5 (3.8, 5.4)	5.1 (4.2, 6.1)	5.3 (4.4, 6.5)	
Osteonecrosis	1.9 (0.5, 7.5)	1.9 (0.5, 7.5)	1.9 (0.5, 7.5)				
Rheumatoid Arthritis	3.1 (1.5, 6.4)	3.7 (1.8, 7.2)	4.6 (2.3, 8.8)	5.9 (3.0, 11.5)			
Rotator Cuff Arthropathy	2.8 (2.3, 3.5)	3.6 (3.0, 4.4)	3.8 (3.2, 4.7)	5.3 (4.2, 6.6)	5.6 (4.4, 7.0)	5.6 (4.4, 7.0)	
Other (4)	5.1 (2.6, 10.0)	5.1 (2.6, 10.0)	6.5 (3.3, 12.7)				

Note: Only Primary Diagnoses with over 100 procedures have been listed.

Figure ST23 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Primary Diagnosis



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Fracture	1362	951	639	402	137	71	20	2
Osteoarthritis	4453	3302	2506	1839	831	436	153	20
Rheumatoid Arthritis	242	190	141	101	46	24	8	4
Rotator Cuff Arthropathy	3250	2412	1677	1118	375	161	67	19

Table ST47 Primary Total Reverse Shoulder Replacement by Reason for Revision

Reason for Revision	Number	Percent
Instability/Dislocation	144	42.2
Loosening/Lysis	66	19.4
Infection	52	15.2
Fracture	39	11.4
Pain	5	1.5
Implant Breakage Glenoid	4	1.2
Malposition	4	1.2
Incorrect Sizing	4	1.2
Dissociation	4	1.2
Rotator Cuff Insufficiency	2	0.6
Arthrofibrosis	2	0.6
Wear Glenoid Insert	1	0.3
Implant Breakage Glenoid Insert	1	0.3
Metal Related Pathology	1	0.3
Prosthesis Dislocation	1	0.3
Other	11	3.2
TOTAL	341	100.0

Table ST48 Primary Total Reverse Shoulder Replacement by Type of Revision

Type of Revision	Number	Percent
Cup/Head	91	26.7
Cup Only	74	21.7
Humeral Component	61	17.9
Head Only	53	15.5
Glenoid Component	22	6.5
Humeral/Glenoid	16	4.7
Cement Spacer	11	3.2
Removal of Prostheses	7	2.1
Reoperation	2	0.6
Minor Components	2	0.6
Reinsertion of Components	1	0.3
Head/Insert	1	0.3
TOTAL	341	100.0

Outcome for Osteoarthritis

Age and Gender

Age is not a risk factor for revision of total reverse shoulder replacement undertaken for osteoarthritis (Table ST49, Table ST50 and Figure ST24). Males have a higher rate of revision compared to females in the first three months only (Table ST51, Table ST52 and Figure ST25).

Fixation

Fixation is not a risk factor for revision (Table ST53, Table ST54 and Figure ST26). This is also the case when the SMR prosthesis is excluded from the analysis (Table ST55, Table ST56 and Figure ST27).

The outcomes of the most commonly used prostheses are listed in Table ST57 and Table ST58.

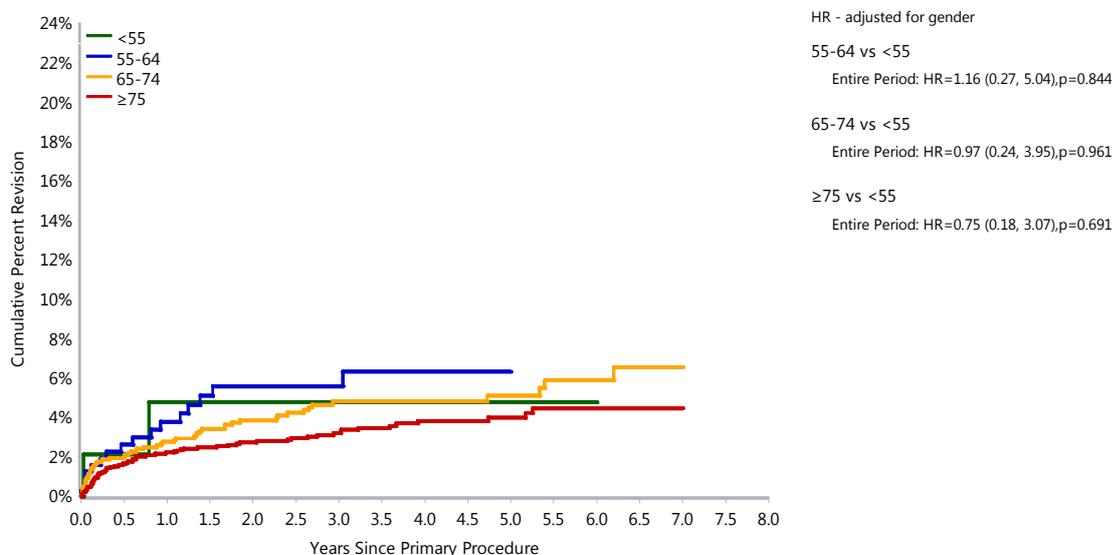
Table ST49 Revision Rates of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	2	47	135	1.48 (0.18, 5.36)
55-64	16	319	891	1.80 (1.03, 2.92)
65-74	61	1516	4191	1.46 (1.11, 1.87)
≥75	77	2571	7243	1.06 (0.84, 1.33)
TOTAL	156	4453	12459	1.25 (1.06, 1.46)

Table ST50 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	4.8 (1.2, 17.9)	4.8 (1.2, 17.9)	4.8 (1.2, 17.9)	4.8 (1.2, 17.9)	4.8 (1.2, 17.9)		
55-64	3.8 (2.1, 6.7)	5.6 (3.4, 9.2)	5.6 (3.4, 9.2)	6.3 (3.8, 10.3)			
65-74	2.8 (2.0, 3.8)	3.9 (2.9, 5.1)	4.8 (3.7, 6.3)	5.1 (3.9, 6.7)	5.9 (4.4, 7.9)	6.6 (4.7, 9.1)	
≥75	2.2 (1.7, 2.9)	2.7 (2.1, 3.5)	3.2 (2.5, 4.1)	4.0 (3.1, 5.1)	4.5 (3.4, 5.8)	4.5 (3.4, 5.8)	

Figure ST24 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
<55	47	35	25	19	10	6	3	1
55-64	319	236	176	131	59	35	14	3
65-74	1516	1104	827	600	298	160	58	6
≥75	2571	1927	1478	1089	464	235	78	10

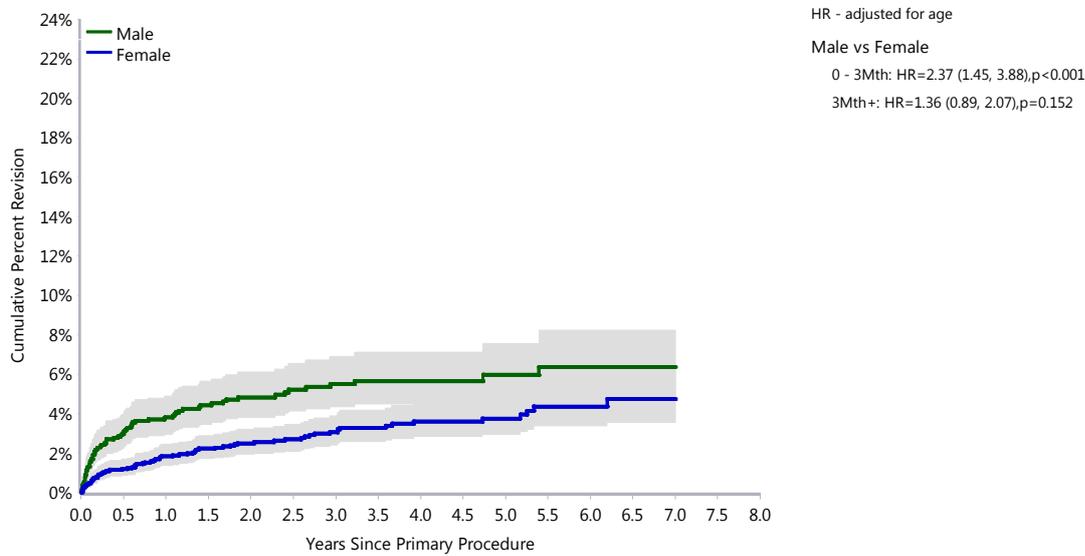
Table ST51 Revision Rates of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	76	1604	4269	1.78 (1.40, 2.23)
Female	80	2849	8189	0.98 (0.77, 1.22)
TOTAL	156	4453	12459	1.25 (1.06, 1.46)

Table ST52 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	3.8 (2.9, 4.9)	4.8 (3.8, 6.1)	5.5 (4.4, 6.9)	6.0 (4.7, 7.6)	6.4 (4.9, 8.2)	6.4 (4.9, 8.2)	6.4 (4.9, 8.2)
Female	1.8 (1.4, 2.4)	2.5 (1.9, 3.2)	3.1 (2.4, 3.9)	3.8 (2.9, 4.8)	4.4 (3.4, 5.7)	4.7 (3.6, 6.3)	4.7 (3.6, 6.3)

Figure ST25 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	1604	1130	860	609	279	146	57	5
Female	2849	2172	1646	1230	552	290	96	15

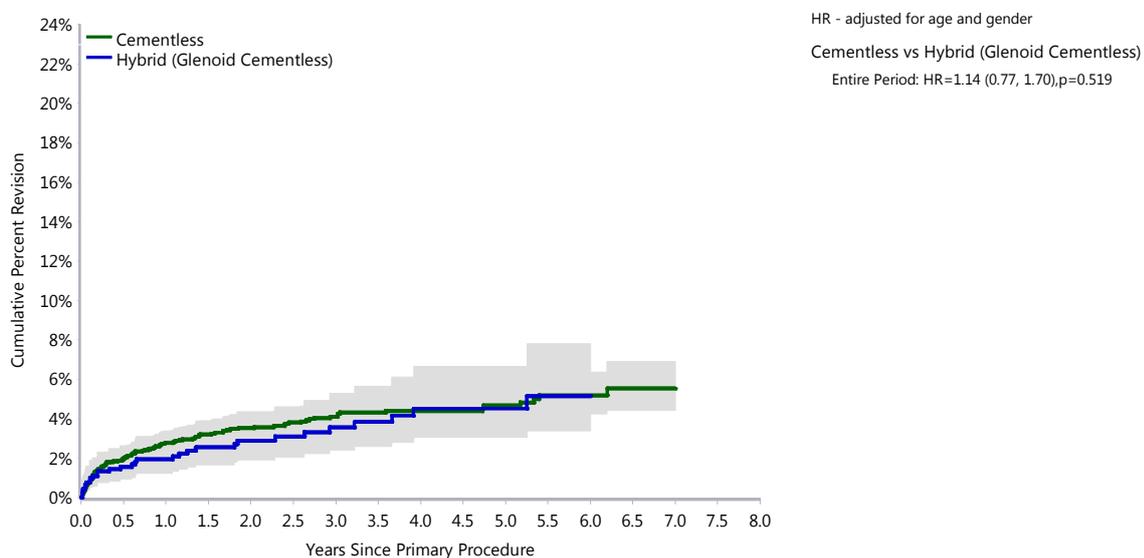
Table ST53 Revision Rates of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	0	55	232	0.00 (0.00, 1.59)
Cementless	126	3464	9597	1.31 (1.09, 1.56)
Hybrid (Glenoid Cemented)	0	17	31	0.00 (0.00, 11.89)
Hybrid (Glenoid Cementless)	30	917	2599	1.15 (0.78, 1.65)
TOTAL	156	4453	12459	1.25 (1.06, 1.46)

Table ST54 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	2.8 (2.2, 3.4)	3.5 (2.9, 4.3)	4.1 (3.4, 4.9)	4.7 (3.9, 5.6)	5.2 (4.2, 6.4)	5.5 (4.4, 6.9)	
Hybrid (Glenoid Cementless)	1.9 (1.2, 3.1)	2.9 (1.9, 4.3)	3.6 (2.4, 5.3)	4.5 (3.1, 6.6)	5.2 (3.4, 7.8)		

Figure ST26 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	3464	2550	1929	1414	638	327	107	20
Hybrid (Glenoid Cementless)	917	691	523	384	173	92	39	0

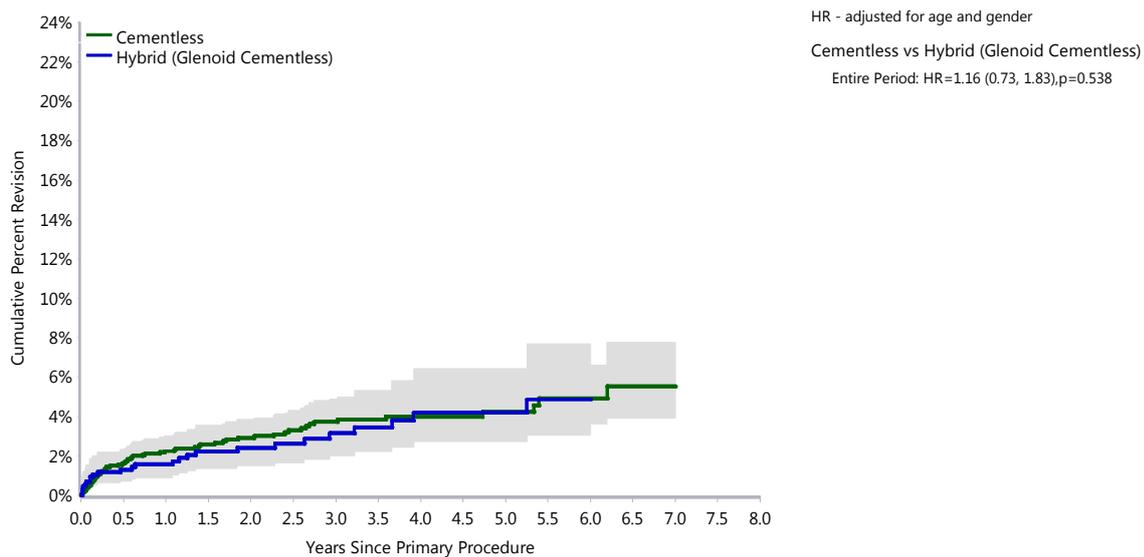
Table ST55 Revision Rates of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	0	55	232	0.00 (0.00, 1.59)
Cementless	66	2087	5542	1.19 (0.92, 1.52)
Hybrid (Glenoid Cemented)	0	13	21	0.00 (0.00, 17.28)
Hybrid (Glenoid Cementless)	25	856	2412	1.04 (0.67, 1.53)
TOTAL	91	3011	8207	1.11 (0.89, 1.36)

Table ST56 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cemented	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
Cementless	2.3 (1.7, 3.0)	2.9 (2.2, 3.8)	3.7 (2.9, 4.8)	4.2 (3.2, 5.5)	4.9 (3.6, 6.6)	5.5 (3.9, 7.8)	
Hybrid (Glenoid Cemented)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)					
Hybrid (Glenoid Cementless)	1.6 (0.9, 2.7)	2.4 (1.5, 3.8)	3.2 (2.0, 4.9)	4.2 (2.7, 6.4)	4.9 (3.1, 7.7)		

Figure ST27 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	2087	1503	1114	791	348	177	59	13
Hybrid (Glenoid Cementless)	856	644	484	354	164	87	38	0

Table ST57 Revision Rates of Primary Total Reverse Shoulder Replacement by Humeral Stem and Glenoid (Primary Diagnosis OA)

Humeral Stem	Glenoid Component	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	32	689	1950	1.64 (1.12, 2.32)
Aequalis Ascend	Aequalis	0	44	17	0.00 (0.00, 21.47)
Comprehensive	Comprehensive Reverse	3	76	93	3.22 (0.66, 9.40)
Delta CTA	Delta CTA	7	64	376	1.86 (0.75, 3.83)
Delta Xtend	Delta Xtend	35	1631	4587	0.76 (0.53, 1.06)
Equinox	Equinox	1	31	38	2.61 (0.07, 14.56)
Promos	Promos	2	40	191	1.04 (0.13, 3.77)
RSP	RSP	2	82	55	3.67 (0.44, 13.26)
SMR	SMR	65	1440	4237	1.53 (1.18, 1.96)
Trabecular Metal	Trabecular Metal	8	285	808	0.99 (0.43, 1.95)
Other (11)		1	71	104	0.96 (0.02, 5.36)
TOTAL		156	4453	12459	1.25 (1.06, 1.46)

Note: Only combinations with over 25 procedures have been listed.

Table ST58 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Humeral Stem and Glenoid (Primary Diagnosis OA)

Humeral Stem	Glenoid Component	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	Aequalis	2.3 (1.4, 3.8)	3.5 (2.3, 5.3)	5.4 (3.7, 7.9)	6.7 (4.6, 9.7)	7.8 (5.1, 11.8)		
Aequalis Ascend	Aequalis							
Comprehensive	Comprehensive Reverse	4.4 (1.4, 13.1)	4.4 (1.4, 13.1)	4.4 (1.4, 13.1)				
Delta CTA	Delta CTA	7.8 (3.3, 17.8)	7.8 (3.3, 17.8)	9.4 (4.3, 19.8)	9.4 (4.3, 19.8)	9.4 (4.3, 19.8)	11.6 (5.7, 23.1)	11.6 (5.7, 23.1)
Delta Xtend	Delta Xtend	1.6 (1.1, 2.4)	2.0 (1.4, 2.8)	2.1 (1.5, 3.0)	2.7 (1.9, 4.0)	3.5 (2.3, 5.3)	3.5 (2.3, 5.3)	
Equinox	Equinox	4.5 (0.7, 28.1)	4.5 (0.7, 28.1)					
Promos	Promos	0.0 (0.0, 0.0)	5.0 (1.3, 18.5)	5.0 (1.3, 18.5)	5.0 (1.3, 18.5)			
RSP	RSP	2.6 (0.7, 10.0)						
SMR	SMR	3.6 (2.8, 4.8)	4.6 (3.6, 5.9)	4.9 (3.8, 6.3)	5.5 (4.2, 7.0)	5.8 (4.4, 7.6)	5.8 (4.4, 7.6)	
Trabecular Metal	Trabecular Metal	1.5 (0.6, 4.1)	2.6 (1.2, 5.8)	4.0 (2.0, 8.1)	4.0 (2.0, 8.1)			
Other (11)		2.3 (0.3, 15.1)	2.3 (0.3, 15.1)	2.3 (0.3, 15.1)				

Note: Only combinations with over 25 procedures have been listed.

Outcome for Rotator Cuff Arthropathy

Age and Gender

Age is not a risk factor for revision of total reverse shoulder replacement undertaken for rotator cuff arthropathy (Table ST59, Table ST60 and Figure ST28).

Males have a higher rate of revision of total reverse shoulder replacement undertaken for rotator cuff arthropathy compared to females in the first three months only (Table ST61, Table ST62 and Figure ST29).

Fixation

Fixation is not a risk factor for revision (Table ST63, Table ST64 and Figure ST30). This is also the case when the SMR total reverse shoulder is excluded from the analysis (Table ST65, Table ST66 and Figure ST31).

The outcomes of the most commonly used prostheses are listed in Table ST67 and Table ST68.

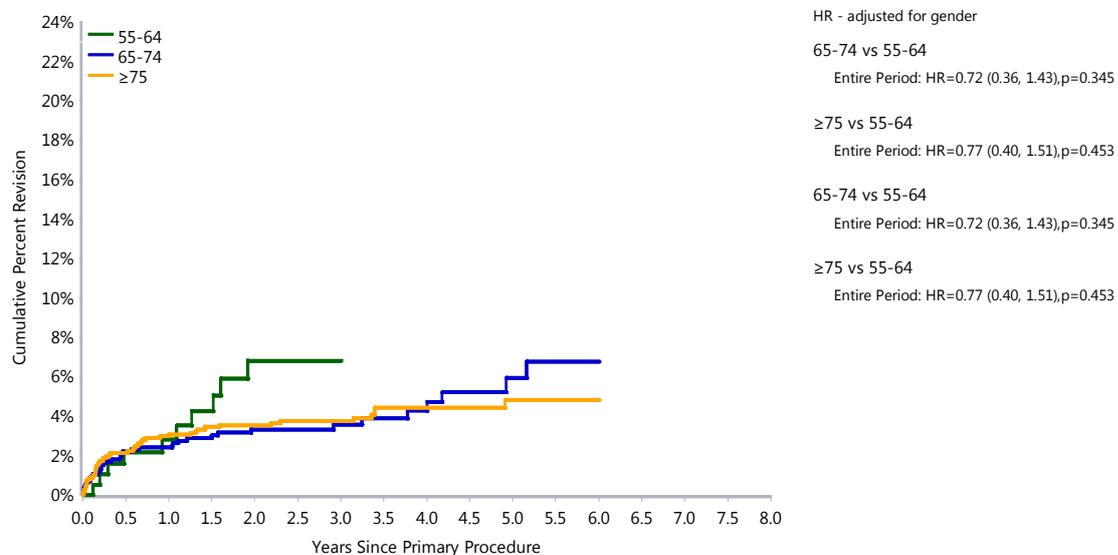
Table ST59 Revision Rates of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis Rotator Cuff Arthropathy)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	0	17	43	0.00 (0.00, 8.51)
55-64	10	199	469	2.13 (1.02, 3.92)
65-74	40	1143	2748	1.46 (1.04, 1.98)
≥75	68	1891	4712	1.44 (1.12, 1.83)
TOTAL	118	3250	7973	1.48 (1.23, 1.77)

Table ST60 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis Rotator Cuff Arthropathy)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
55-64	2.8 (1.2, 6.7)	6.8 (3.7, 12.4)	6.8 (3.7, 12.4)				
65-74	2.4 (1.6, 3.5)	3.3 (2.4, 4.7)	3.6 (2.5, 5.0)	5.9 (3.9, 8.9)	6.8 (4.4, 10.4)		
≥75	3.1 (2.4, 4.0)	3.5 (2.8, 4.5)	3.8 (2.9, 4.8)	4.8 (3.6, 6.4)	4.8 (3.6, 6.4)		

Figure ST28 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis Rotator Cuff Arthropathy)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
55-64	199	144	100	67	22	10	3	1
65-74	1143	849	585	368	127	59	28	7
≥75	1891	1406	983	678	224	90	35	11

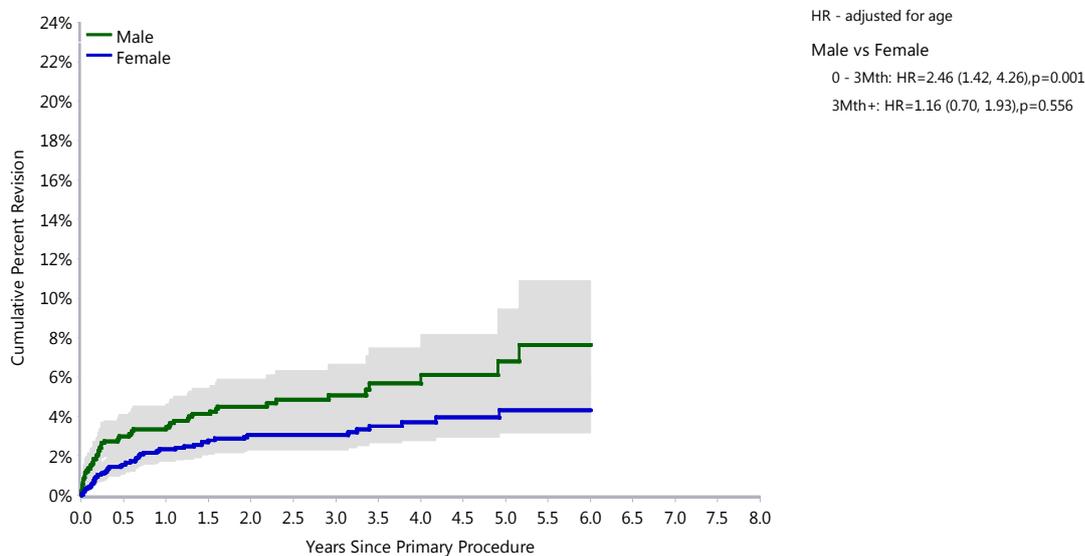
Table ST61 Revision Rates of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis Rotator Cuff Arthropathy)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	60	1316	2998	2.00 (1.53, 2.58)
Female	58	1934	4975	1.17 (0.89, 1.51)
TOTAL	118	3250	7973	1.48 (1.23, 1.77)

Table ST62 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis Rotator Cuff Arthropathy)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	3.5 (2.6, 4.6)	4.5 (3.4, 5.9)	5.1 (3.9, 6.6)	6.8 (4.9, 9.5)	7.6 (5.3, 10.9)		
Female	2.3 (1.7, 3.2)	3.1 (2.3, 4.0)	3.1 (2.3, 4.0)	4.3 (3.2, 5.9)	4.3 (3.2, 5.9)		

Figure ST29 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis Rotator Cuff Arthropathy)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Male	1316	930	635	397	125	63	30	8
Female	1934	1482	1042	721	250	98	37	11

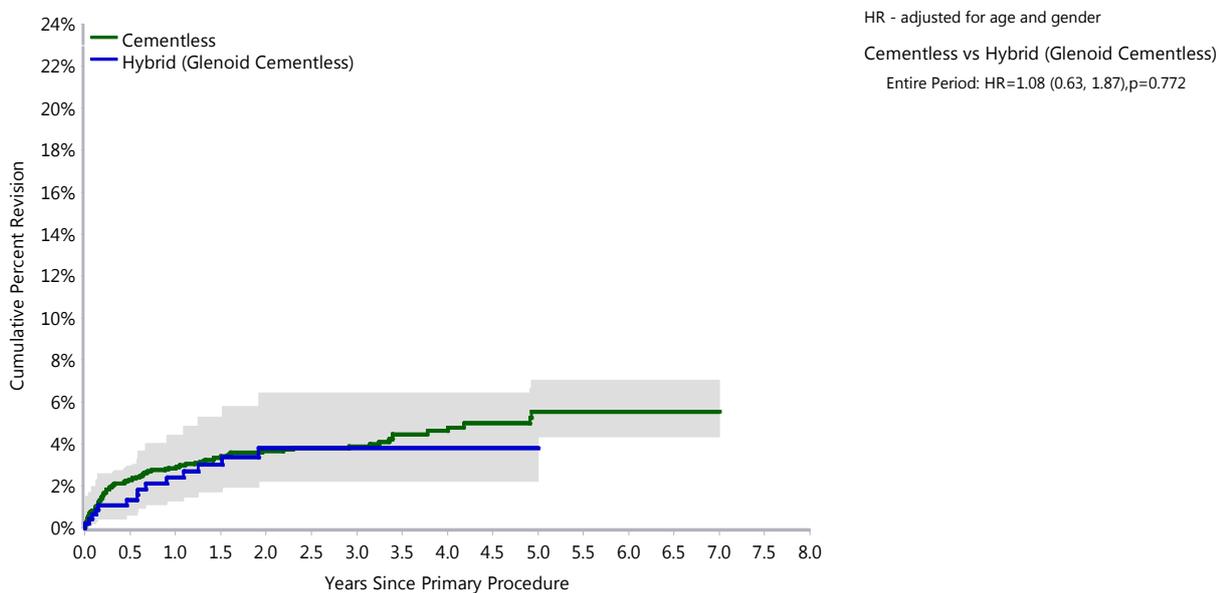
Table ST63 Revision Rates of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis Rotator Cuff Arthropathy)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	0	10	35	0.00 (0.00, 10.46)
Cementless	103	2758	6844	1.50 (1.23, 1.83)
Hybrid (Glenoid Cemented)	0	16	26	0.00 (0.00, 14.21)
Hybrid (Glenoid Cementless)	15	466	1068	1.41 (0.79, 2.32)
TOTAL	118	3250	7973	1.48 (1.23, 1.77)

Table ST64 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis Rotator Cuff Arthropathy)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	2.9 (2.3, 3.6)	3.7 (3.0, 4.5)	3.9 (3.2, 4.8)	5.5 (4.3, 7.1)	5.5 (4.3, 7.1)	5.5 (4.3, 7.1)	5.5 (4.3, 7.1)
Hybrid (Glenoid Cementless)	2.4 (1.3, 4.4)	3.8 (2.2, 6.4)	3.8 (2.2, 6.4)	3.8 (2.2, 6.4)			

Figure ST30 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis Rotator Cuff Arthropathy)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	2758	2057	1445	970	326	146	62	16
Hybrid (Glenoid Cementless)	466	336	220	141	46	13	5	3

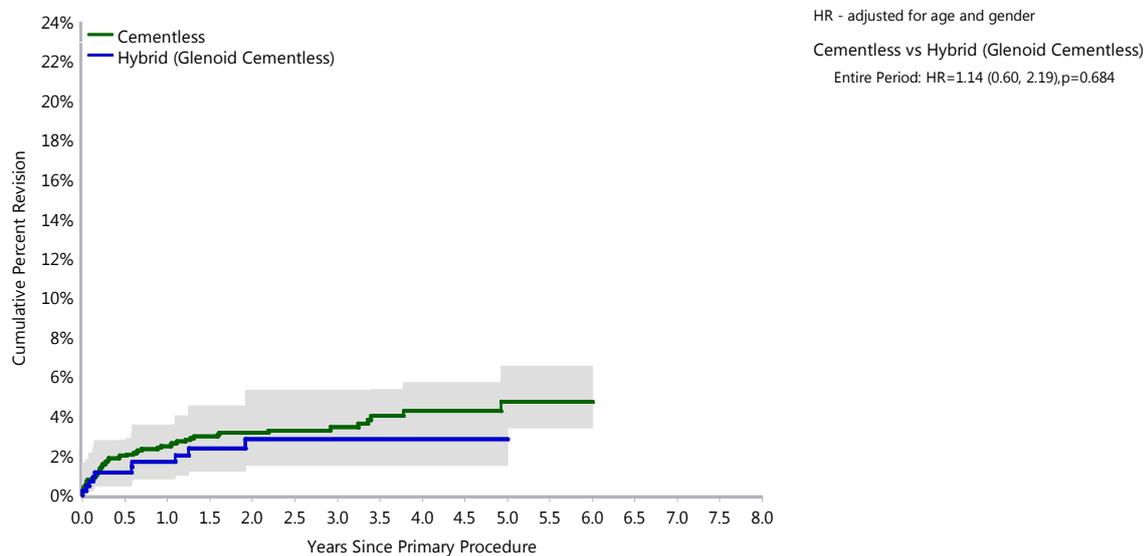
Table ST65 Revision Rates of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis Rotator Cuff Arthropathy, excluding SMR)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	0	8	22	0.00 (0.00, 17.03)
Cementless	57	1762	4214	1.35 (1.02, 1.75)
Hybrid (Glenoid Cemented)	0	13	26	0.00 (0.00, 14.39)
Hybrid (Glenoid Cementless)	11	438	992	1.11 (0.55, 1.98)
TOTAL	68	2221	5254	1.29 (1.01, 1.64)

Table ST66 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis Rotator Cuff Arthropathy, excluding SMR)

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	2.5 (1.8, 3.4)	3.2 (2.4, 4.2)	3.4 (2.6, 4.6)	4.7 (3.4, 6.6)	4.7 (3.4, 6.6)		
Hybrid (Glenoid Cementless)	1.7 (0.8, 3.6)	2.8 (1.5, 5.3)	2.8 (1.5, 5.3)	2.8 (1.5, 5.3)			

Figure ST31 Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis Rotator Cuff Arthropathy, excluding SMR)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Cementless	1762	1284	883	585	197	81	30	10
Hybrid (Glenoid Cementless)	438	316	205	130	41	11	4	2

Table ST67 Revision Rates of Primary Total Reverse Shoulder Replacement by Humeral Stem and Glenoid (Primary Diagnosis Rotator Cuff Arthropathy)

Humeral Stem	Glenoid Component	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	19	473	1285	1.48 (0.89, 2.31)
Aequalis Ascend	Aequalis	1	34	12	8.65 (0.22, 48.18)
Comprehensive	Comprehensive Reverse	2	38	44	4.51 (0.55, 16.28)
Delta Xtend	Delta Xtend	38	1270	3008	1.26 (0.89, 1.73)
RSP	RSP	1	47	36	2.80 (0.07, 15.61)
SMR	SMR	50	1027	2706	1.85 (1.37, 2.44)
Trabecular Metal	Trabecular Metal	6	273	655	0.92 (0.34, 1.99)
Other (12)		1	88	227	0.44 (0.01, 2.45)
TOTAL		118	3250	7973	1.48 (1.23, 1.77)

Note: Only combinations with over 25 procedures have been listed.

Table ST68 Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Humeral Stem and Glenoid (Primary Diagnosis Rotator Cuff Arthropathy)

Humeral Stem	Glenoid Component	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Aequalis	Aequalis	2.0 (1.0, 3.8)	3.4 (2.0, 5.7)	3.8 (2.3, 6.2)	5.1 (3.0, 8.5)			
Aequalis Ascend	Aequalis							
Comprehensive	Comprehensive Reverse	5.9 (1.5, 21.9)	5.9 (1.5, 21.9)					
Delta Xtend	Delta Xtend	2.3 (1.6, 3.4)	3.1 (2.2, 4.3)	3.3 (2.3, 4.6)	4.5 (3.0, 6.8)	4.5 (3.0, 6.8)		
RSP	RSP	2.3 (0.3, 15.1)						
SMR	SMR	3.8 (2.8, 5.3)	4.8 (3.6, 6.5)	5.0 (3.8, 6.7)	7.1 (5.1, 10.0)	7.1 (5.1, 10.0)		
Trabecular Metal	Trabecular Metal	2.3 (1.0, 5.0)	2.3 (1.0, 5.0)	2.3 (1.0, 5.0)				
Other (12)		1.1 (0.2, 7.8)	1.1 (0.2, 7.8)	1.1 (0.2, 7.8)	1.1 (0.2, 7.8)	1.1 (0.2, 7.8)	1.1 (0.2, 7.8)	

Note: Only combinations with over 25 procedures have been listed.

PROSTHESES WITH HIGHER THAN ANTICIPATED RATES OF REVISION

Introduction

A unique and important function of registries is that they are able to provide population based data on the comparative outcome of individual prostheses in a community. Outcomes data are necessary to enable an evidence-based approach to prosthesis selection. For many prostheses, the only source of outcomes data are registry reports.

It is evident from Registry data that most prostheses have similar outcomes. A number, however, have revision rates that are statistically higher than other prostheses in the same class. The Registry identifies these as 'prostheses with a higher than anticipated rate of revision'.

The Registry has developed a standardised three-stage approach to identify prostheses that are outliers with respect to revision rate. The comparator group includes all other prostheses within the same class regardless of their rate of revision. This is a more pragmatic approach than comparing to a select group of prostheses with the lowest revision rates.

Stage 1

The first stage is a screening test to identify prostheses that differ significantly from the combined revisions per 100 observed component years of all other prostheses in the same class. It is an automated analysis that identifies prostheses based on set criteria. These include:

- (i) the revision rate (per 100 component years) exceeds twice that for the group, and
- (ii) the Poisson probability of observing that number of revisions, given the rate of the group is significant ($p < 0.05$), and

either

- (iii) there are at least 10 primary procedures for that component,

or

- (iv) the proportion revised is at least 75% and there have been at least two revisions.

The Registry has the capacity to assess the outcome of individual prostheses or the combination of prostheses used in a procedure. It is apparent from previous reports that individual prostheses that perform well in one combination may not perform well in another. Therefore, the outcome of an individual prosthesis is partly dependent on the combination of the different prostheses used.

Consequently, the Registry undertakes two different analyses in Stage 1. The first assesses the outcome of all combinations. The second assesses all individual prostheses regardless of the combination. Both analyses are reviewed to determine if a higher revision rate is identified with a single combination, multiple combinations or uniformly with all combinations. If prostheses are identified in a single combination, that combination progresses to Stage 2. An individual prosthesis progresses to Stage 2 if it is identified in multiple combinations or uniformly across all combinations.

Stage 2

In Stage 2, the AOANJRR Director and Deputy Directors in conjunction with DMAC staff, review the identified prostheses and undertake further investigation. This includes examining for the impact of confounders, and calculating age and gender adjusted hazard ratios. In addition, all prostheses identified in previous reports are re-analysed as part of the Stage 2 analysis. This is not dependent on re-identification in Stage 1. If there is a significant difference compared to the combined hazard rate of all other prostheses in the same class then the prosthesis or prostheses combination progress to Stage 3. The possible exception to this is the presence of confounding factors, such as use in complex primary procedures.

Stage 3

The final stage involves review by a panel of independent orthopaedic specialists from the Australian Shoulder and Elbow Society. The panel meets with Registry staff at one day workshop to review the Stage 2 analysis and determine which prostheses will be identified in the Annual Report.

Identified Prostheses

Identified prostheses are listed in one of three groups. The first group, 'Newly Identified', lists prostheses that are identified for the first time and are still used.

The second group is 'Re-identified and still used'. This listing identifies the prostheses which continue to have a higher than anticipated rate of revision and provides information on its continued use. Most identified or re-identified prostheses decline in use. This is usually evident only after the first year because almost a full year of use has occurred prior to identification in the Annual Report.

Prostheses that have a higher rate of revision but are no longer used in Australia make up the third group, 'Identified and no longer used'. These are listed to provide ongoing information on the rate of revision. This also enables comparison of other prostheses to the discontinued group. This group may include prostheses that are no longer used in Australia that are identified for the first time.

The Registry does not make a recommendation or otherwise on the continued use of identified prostheses. Identification is made to ensure that prostheses with a higher rate of revision compared to others in the same class are highlighted.

On occasion, a prosthesis previously identified no longer meets the criteria for inclusion. In this situation, the prosthesis is not subsequently re-identified. Registries monitor the continual real time performance of prostheses within a community and the Annual Report provides a snap shot at a particular time. It is necessary to appreciate that outcomes are continually changing and that many factors may influence that change, including identification in the report.

The current approach used by the Registry is most effective at identifying the relative performance of recently introduced prostheses. As the Registry's follow up period increases, it is becoming evident that prostheses with a delayed onset of higher rates of revision are not as readily identified by this approach. The Registry will develop further strategies in the future to identify these prostheses.

This year, six upper limb specialists attended the workshop under the leadership of Richard Page, together with the AOANJRR Director and one Deputy Director.

Only prostheses identified for the first time or prostheses that are not re-identified are discussed in the following text.

The full analysis for all prostheses identified as having a higher than anticipated rate of revision in the 2015 Annual Report are available on the Registry website, <https://aoanjrr.dmac.adelaide.edu.au/annual-reports-2015>.

Primary Hemi Stemmed Shoulder Replacement

There are two newly identified hemi stemmed shoulder prostheses.

The Delta Xtend combination has been used in 52 procedures and has a five year cumulative percent revision of 16.6%. There have been seven revisions, of which all are major. Two involved revision of the humeral and glenoid components, four revised the glenoid component only and one the humeral component only. The main reason for revision is instability/dislocation (42.9%), followed by glenoid erosion (28.6%).

The Global Unite Combination has been used in 73 procedures and has a two year cumulative percent revision of 24.7%. There have been seven revisions, of which all are major. Six involved revision of the humeral and glenoid components and one the humeral component only. The main reason for revision is rotator cuff insufficiency (57.1%) followed by pain (28.6%).

Table IP1 Revision Rate of Individual Hemi Stemmed Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

Humeral/Head	N Total	Obs. Years	Revisions/100 Obs. Yrs	Hazard Ratio, P Value
Newly Identified				
Delta Xtend/Delta Xtend	52	165	4.24	Entire Period: HR=2.41 (1.14, 5.12),p=0.021
Global Unite/Global Unite	73	89	7.82	Entire Period: HR=2.50 (1.17, 5.34),p=0.018

Note: All Components have been compared to all other Hemi Stemmed Shoulder components.

Table IP2 Yearly Cumulative Percent Revision of Individual Hemi Stemmed Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

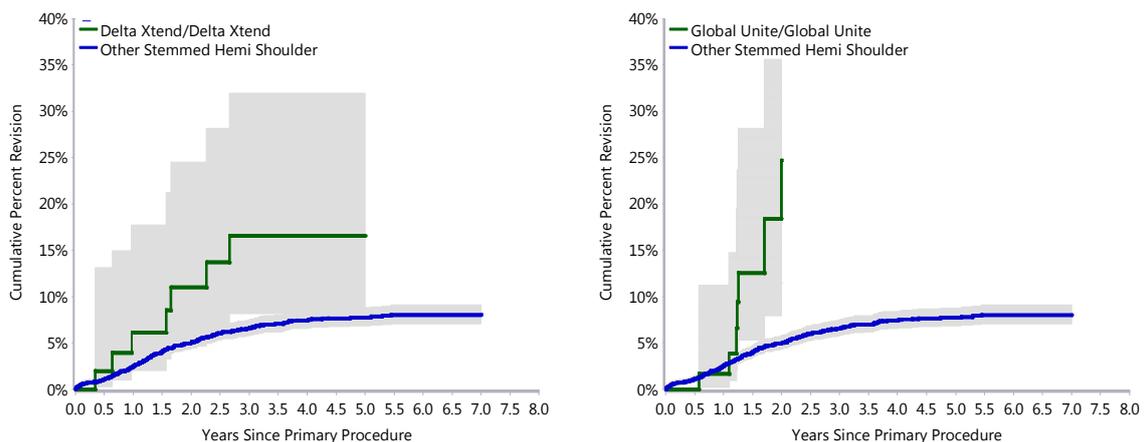
CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Newly Identified							
Delta Xtend/Delta Xtend	6.1 (2.0, 17.7)	11.0 (4.7, 24.5)	16.6 (8.2, 31.9)	16.6 (8.2, 31.9)			
Global Unite/Global Unite	1.7 (0.2, 11.2)	24.7 (11.4, 48.3)					

Table IP3 Yearly Usage of Individual Hemi Stemmed Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

Year of Implant	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Newly Identified											
Delta Xtend/Delta Xtend				2	5	9	9	5	10	7	5
Global Unite/Global Unite									15	36	22

Newly Identified

Figure IP1 Cumulative Percent Revision of Individual Hemi Stemmed Shoulder Prostheses identified as having a Higher than Anticipated Revision Rate



Primary Total Conventional Shoulder Replacement

There are no newly identified total conventional shoulder prostheses.

shoulder prostheses. In 2014 there were an additional 44 procedures and no further revisions.

The Comprehensive combination is no longer significantly different from all other total conventional

Table IP4 Revision Rate of Individual Total Conventional Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

Humeral/Glenoid	N Total	Obs. Years	Revisions/100 Obs. Yrs	Hazard Ratio, P Value
Re-Identified and still used				
SMR/SMR L1	1321	4279	2.71	Entire Period: HR=1.64 (1.33, 2.01),p<0.001
Vaios/Vaios	36	88	10.20	Entire Period: HR=4.48 (2.32, 8.66),p<0.001
Identified and no longer used				
SMR/SMR L2	856	2756	7.84	0 - 1.5Yr: HR=4.44 (3.53, 5.58),p<0.001 1.5Yr+: HR=9.37 (7.08, 12.41),p<0.001
Univers 3D/Univers 3D	34	193	5.71	Entire Period: HR=3.99 (2.19, 7.27),p<0.001

Note: All Components have been compared to all other Total Conventional Shoulder components.

Table IP5 Yearly Cumulative Percent Revision of Individual Total Conventional Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

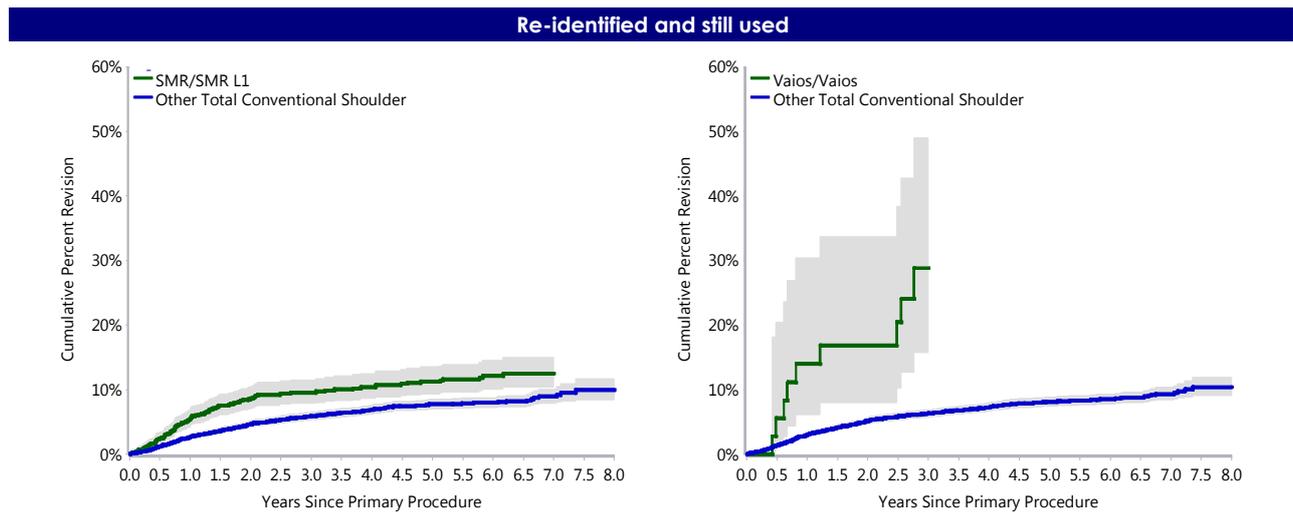
CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Re-Identified and still used							
SMR/SMR L1	5.5 (4.3, 7.0)	8.6 (7.1, 10.5)	9.5 (7.9, 11.5)	11.2 (9.3, 13.5)	12.1 (10.1, 14.6)	12.5 (10.3, 15.0)	
Vaios/Vaios	14.0 (6.1, 30.4)	16.8 (7.9, 33.7)	28.8 (15.8, 49.0)				
Identified and no longer used							
SMR/SMR L2	9.4 (7.6, 11.6)	17.1 (14.7, 19.8)	21.8 (19.1, 24.7)				
Univers 3D/Univers 3D	5.9 (1.5, 21.5)	14.7 (6.4, 31.8)	14.7 (6.4, 31.8)	21.2 (10.7, 39.4)	27.7 (15.4, 46.6)	31.5 (18.2, 50.9)	

Table IP6 Yearly Usage of Individual Total Conventional Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

Year of Implant	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Re-Identified and still used											
SMR/SMR L1			16	119	237	247			157	297	248
Vaios/Vaios								16	17	2	1
Identified and no longer used											
SMR/SMR L2						43	343	336	134		
Univers 3D/Univers 3D		1	6	16	11						

Note: The SMR L1 was not used in 2010 and 2011 due to the exclusive use of the SMR L2 in Total Conventional Shoulder Replacement

Figure IP2 Cumulative Percent Revision of Individual Total Conventional Shoulder Prostheses Re-identified and still used



Primary Total Reverse Shoulder Replacement

There are no newly identified total reverse shoulder prostheses.

Table IP7 Revision Rate of Individual Total Reverse Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

Humeral/Glenoid	N Total	Obs. Years	Revisions/100 Obs. Yrs	Hazard Ratio, P Value
Re-Identified and still used				
SMR/SMR L1	2090	5219	1.86	Entire Period: HR=1.51 (1.19, 1.91),p<0.001

Note: All Components have been compared to all other Total Reverse Shoulder components

Table IP8 Yearly Cumulative Percent Revision of Individual Total Reverse Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

CPR	1 Yr	2 Yrs	3 Yrs	5 Yrs	6 Yrs	7 Yrs	8 Yrs
Re-Identified and still used							
SMR/SMR L1	4.0 (3.2, 5.0)	4.9 (4.0, 6.1)	5.2 (4.2, 6.5)	6.2 (5.0, 7.8)	6.7 (5.3, 8.3)	6.7 (5.3, 8.3)	

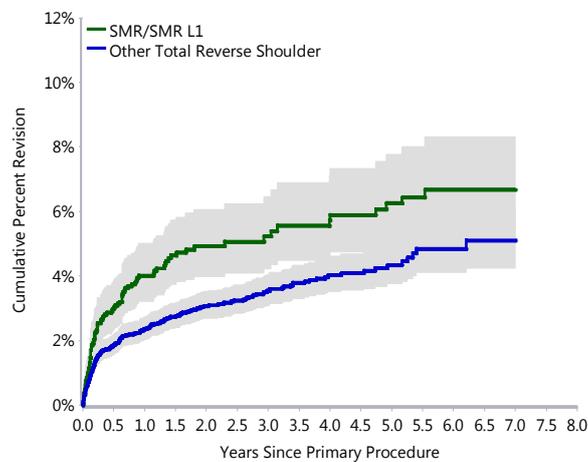
Table IP9 Yearly Usage of Individual Total Reverse Shoulder Prostheses Identified as having a Higher than Anticipated Revision Rate

Year of Implant	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Re-Identified and still used											
SMR/SMR L1		2	19	124	261	271			249	560	604

Note: The SMR L1 was not used in 2010 and 2011 due to the exclusive use of the SMR L2 in Total Reverse Shoulder Replacement

Figure IP3 Cumulative Percent Revision of Individual Total Reverse Shoulder Prostheses Re-identified and still used

Re-identified and still used



APPENDICES

Appendix 1

Glossary of Statistical Terms

Adjustment: The process of re-estimating a crude measure, such as a rate or rate ratio, to minimise the effects of a difference in the distribution of a characteristic, such as age, between groups being compared on that measure. Adjustment may be carried out in the context of a modelling procedure, for example, linear or proportional hazards regression models, or by standardising the data set against a reference population with a known age distribution, for example, the World Standard Population or the Australian population defined by the Australian Bureau of Statistics Census in a specified year.

Censoring: When the outcome of interest is the time to a defined event, for example, revision of a prosthesis, the event may not occur during the available period of observation. For example, the Registry analyses its data on prosthesis revision for the period ending 31 December each year, and many prostheses will not have been revised by that time. Unless the prosthesis was revised prior to 31 December the outcome is unknown. For the majority, we only know that up until 31 December they had not yet been revised. The times to revision for these prostheses are said to have been censored at 31 December. Statistical methods exist to ensure that censored data are not ignored in analysis, rather information on survival up until the time of censoring is used to give the best possible estimates of survival or revision probabilities.

Chi-Square Test (χ^2) Test: Any test whose statistic has a chi-square distribution under the null hypothesis is called a chi-square test. A common example is a test for association between two categorical variables whose data are arrayed in a cross-classification table of counts (Pearson's chi-square test). This can be generalised to many situations where the distribution of observed data is being compared to an expected theoretical distribution.

Competing Risk: Any event that changes the probability of occurrence of another event is known as a competing risk for the other event. For example, death is a competing risk for revision because the probability of revision after death cannot be assumed to be the same as the probability of revision before death. Another example is that if interest centres on specific causes of revision, then each cause (infection, loosening etc) is a competing risk for each other cause. Treating a competing risk event as a right censoring will bias the estimation of the risk of the event of interest.

Confidence Interval: A set of values for a summary measure, such as a rate or rate ratio, constructed so the set has a specified probability of including the true value of the measure. The specified probability is called the confidence interval, the end points are called lower and upper confidence limits; 95% confidence intervals are most common.

Cox Model or Proportional Hazards Model: A statistical model that relates the hazard for an individual at any time t to an (unspecified) baseline hazard and a set of predictor variables, such as treatment type, age, gender etc. The Cox model produces hazard ratios that allow comparisons between groups of the rate of the event of interest. The main assumption of a Cox model is that the ratio of hazards between, say, two groups that we wish to compare, does not vary over time. If the hazard for prosthesis Model A is twice that of prosthesis Model B at three years, it will also be twice at four years, and so on. This is referred to as the 'proportional hazards assumption'. If the hazard ratio is not proportional over the entire time of observation then a time varying model is used, which estimates a separate hazard ratio within each pre-defined time period. Within each time period, the hazards are proportional. The Registry uses a set algorithm which iteratively chooses time points until the assumption of proportional hazards is met for each time period. The time points are selected based on where the greatest change in hazard occurs between the two comparison groups, weighted by the number of events in that time period.

Cumulative Incidence Function: An estimator of the actual probability of revision in the presence of a competing risk. In these circumstances, the Kaplan-Meier estimate, which treats competing risks as censored, overestimates the true probability. In the competing risks paradigm, patients who have already had a revision or died are excluded from the set at risk of being revised. Under Kaplan-Meier only patients who have already been revised are excluded from the risk set; dead patients are analysed as though they are still at risk of revision.

Cumulative Percent Revision: otherwise known as the 'cumulative failure rate'. This is defined as $100 \times [1 - S(t)]$ where $S(t)$ is the survivorship probability estimated by the Kaplan-Meier method (see survival curve, below). The cumulative percent revision gives the percent of procedures revised up until time t , and allows for right censoring due to death (but see Cumulative Incidence Function above) or closure of the database for analysis.

Hazard Ratio: A hazard is an estimate of the instantaneous risk of occurrence of an event, for example death, at a point in time, t . This is sometimes called the 'force of mortality'. A hazard ratio results from dividing one group's hazard by another's to give a comparative measure of the instantaneous risk of experiencing the event of interest. In this report, hazard ratios are adjusted for age and gender as appropriate. Hazard ratios are either for the entire survivorship period (if proportional; see "Cox Model or Proportional Hazards Model" section above) or for specific time periods (if the hazard for the entire survivorship period is not proportional).

For example, a comparison of Primary Total Conventional Hip Replacement for a Primary Diagnosis of Avascular Necrosis (AVN), Developmental Dysplasia of the Hip (DDH) and Osteoarthritis (OA):

1. Avascular Necrosis vs Osteoarthritis.

Entire Period: HR=1.34 (1.16, 1.54), $p < 0.001$

The hazard ratio for this comparison is proportional over the entire time of observation. AVN has a significantly higher rate of event (in this case, revision) compared to OA over the entire time of observation ($p < 0.001$). The hazard is 1.34 times higher for AVN compared to OA and, with 95% confidence, the true hazard for AVN will lie between 1.16 times higher and 1.54 times higher than the hazard for OA.

2. Developmental Dysplasia vs Osteoarthritis

0-3Mth: HR=1.75 (1.21, 2.52), $p = 0.002$

3Mth+: HR=1.07 (0.78, 1.45), $p = 0.683$

The hazard ratio is not proportional over the entire time of observation so the hazard ratio has been divided into two periods; the time from primary arthroplasty to three months following the primary, and three months following the primary to the end of observation. DDH has a significantly higher revision rate compared to OA in the first three months following the primary ($p = 0.002$). The hazard for revision in the first three months is 1.75 times higher for DDH than for OA and, with 95% confidence, the true hazard for DDH will lie between 1.21 and 2.52 times higher. From three months following the primary to the end of observation there is no significant difference in the revision rate between DDH and OA ($p = 0.683$).

Incidence Rate: The number of new occurrences of an event divided by a measure of the population at risk of that event over a specified time period. The population at risk is often given in terms of person-time: for example, if 6 persons are each at risk over 4 months, they contribute $6 \times 1/3 = 2$ person-years to the denominator of the incidence rate. The incidence rate ratio (IRR) is commonly used to compare the incidence rates of two groups. If the two groups incidence rates are the same, an IRR of 1 results.

Log Rank Test: A family of statistical tests that compares the survival experience of two or more groups over the entire time of observation (contrast with comparison of survival at a defined time, e.g. five-year survival.)

Observed Component Years: For each procedure, component time is the time during which it is at risk of being revised. This is calculated as the number of days from the date of the primary procedure until either the date of revision, date of death or end of study (31/12/2014) whichever happens first. This is then divided by 365.25 to obtain the number of 'component years'. Each primary procedure then contributes this calculated number of component years to the overall total component years for a particular category of prosthesis.

For example

1. A primary total hip procedure performed on 1/1/2014 was revised on 1/7/2014. Therefore, the number of days that this procedure is at risk of being revised is 183 days. This prosthesis then contributes 0.5 ($183/365.25$) component years to the overall number of observed component years for the total hip procedure category.
2. A patient with a primary procedure on 1/1/2014 died without being revised on 1/4/2014. This procedure contributes 0.25 component years.
3. A primary procedure occurs on 1/1/2014 and has not been revised. This procedure contributes 1 component year (as observation time is censored at 31/12/2014).

Survival Curve: A plot of the proportion of subjects who have not yet experienced a defined event (for example, death or revision of prosthesis) versus time. The Kaplan-Meier method is the one most commonly used. The curve takes account of subjects whose ultimate survival time is not known, a phenomenon called 'censoring'. The survival estimate at each time is accompanied by a confidence interval based on the method of Greenwood. An interval is interpretable only at the time for which it was estimated and the sequence of intervals (depicted as shading on the Kaplan-Meier curve) cannot be used to judge the significance of any perceived difference over the entire time of observation. Often, for convenience, the curve is presented to show the proportion revised by a certain time, rather than the proportion not being revised ("surviving"). In the Registry, we call this cumulative percent revision (CPR). The Kaplan-Meier method is biased in the presence of a competing risk and will overestimate the risk of revision. In such circumstances, use of the cumulative incidence function for all competing risks, rather than the Kaplan-Meier estimate, is advised. The cumulative incidence of all competing risks must be assessed simultaneously to avoid bias in interpretation.

Appendix 2

Diagnosis Hierarchy for Revision Shoulder Replacement

Rank	Diagnosis	Category
1 2	Tumour Infection	<i>Dominant diagnosis independent of prosthesis/surgery</i>
3 4 5	Incorrect Side Incorrect Sizing Malposition	<i>Surgical procedure</i>
6 7	Metal Related Pathology Loosening/Lysis	<i>Reaction to prosthesis</i>
8 9 10 11 12 13 14	Wear Glenoid Insert Wear Glenoid Wear Humeral Implant Breakage Glenoid Insert Implant Breakage Glenoid Implant Breakage Humeral Implant Breakage Head	<i>Wear and implant breakage</i>
15 16 17	Instability/ Dislocation Rotator Cuff Insufficiency Dissociation	<i>Stability of prosthesis</i>
18	Fracture (Glenoid/Humeral/Periprosthetic)	<i>Fracture of bone</i>
19 20	Progression of Disease Glenoid Erosion	<i>Progression of disease on non-operated part of joint</i>
21 22 23 24	Synovitis Arthrofibrosis Osteonecrosis/AVN Heterotopic Bone	<i>New diseases occurring in association with joint replacement</i>
25	Pain	<i>Pain</i>
26	Other	<i>Remaining diagnoses</i>