Demographics and Outcomes of Shoulder Arthroplasty

SUPPLEMENTARY REPORT 2014

AOA
AUSTRALIAN ORTHOPAEDIC ASSOCIATION

National Joint Replacement Registry

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This is the seventh Shoulder Arthroplasty Annual Report of the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). The analysis is based on 22,544 shoulder procedures reported to the Registry with a procedure date up to and including 31 December 2013. This is an increase of 4,380 procedures compared to last year's 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, 274 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 2013.

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 2014, which is available on the website https://aoanjrr.dmac.adelaide.edu.au/annual-reports-2014.

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.

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 data[1].

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 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

[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.

Annual Report prior to its publication. This year the review workshop was held in Adelaide on the 23 August 2014. Eight orthopaedic surgeons from the Shoulder and Elbow Society attended the workshop, as well as the AOANJRR Director, two Deputy Directors 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

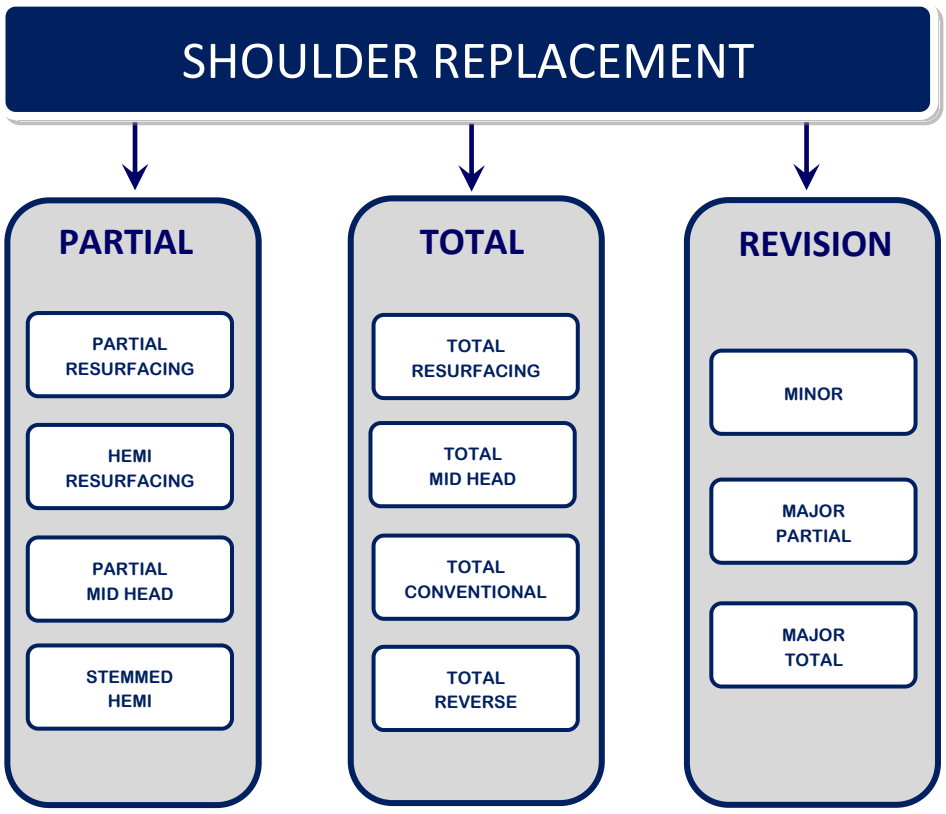
The Registry groups shoulder replacement into three broad categories, primary partial, primary total and revision shoulder replacement.

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 replacement are further sub-categorised into classes depending on the type of prostheses used. Partial shoulder classes are partial resurfacing, hemi resurfacing, partial mid head and stemmed hemi shoulder 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 22,544 shoulder arthroplasty procedures reported to the Registry with a procedure date up to and including 31 December 2013. This is an additional 4,380 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 2013 has increased by 52.6% since 2008.

Shoulder replacement is more common in females (63.1%) with the majority undertaken between the ages of 65 and 84 years. The median age is 74 years for females and 69 years for males (Tables S1-S3 and Figure S1).

The Registry has recorded 1,566 bilateral shoulder replacements, 16.3% of which are performed within six months of the initial procedure with most undertaken between three and six months (11.8%) (Table S4).

Most procedures are undertaken in private hospitals (69.1%) and this proportion has remained constant since the Registry began data collection (Figure S2).

Of all shoulder procedures, total shoulder replacement is the most common. The proportion of total shoulder replacement has increased from 57.6% in 2008 to 75.7% in 2013. Between 2008 and 2013, partial shoulder replacement has decreased from 32.6% to 13.7% and revision procedures have increased from 9.8% to 10.6% (Figure S3).

Table S1: Number of Shoulder Replacement by Gender

Shoulder Replacement	Female		Male		TOTAL	
	N	%	N	%	N	%
Partial Resurfacing	27	23.3	89	76.7	116	2.3
Hemi Resurfacing	514	44.5	640	55.5	1154	23.3
Stemmed Hemi Shoulder	2728	74.4	940	25.6	3668	74.0
Partial Mid Head	10	55.6	8	44.4	18	0.4
Primary Partial	**3279**	**66.2**	**1677**	**33.8**	**4956**	**100.0**
Total Resurfacing	62	39.5	95	60.5	157	1.0
Total Conventional	4479	59.2	3081	40.8	7560	49.4
Total Reverse	4983	67.2	2433	32.8	7416	48.5
Total Mid Head	92	53.2	81	46.8	173	1.1
Primary Total	**9616**	**62.8**	**5690**	**37.2**	**15306**	**100.0**
Revision	**1336**	**58.5**	**946**	**41.5**	**2282**	**100.0**
TOTAL	**14231**	**63.1**	**8313**	**36.9**	**22544**	**100.0**

Table S2: Number of Shoulder Replacement by Age

Shoulder Replacement	<55		55-64		65-74		75-84		≥85		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%
Partial Resurfacing	78	67.2	9	7.8	13	11.2	13	11.2	3	2.6	116	2.3
Hemi Resurfacing	216	18.7	322	27.9	359	31.1	212	18.4	45	3.9	1154	23.3
Stemmed Hemi Shoulder	299	8.2	677	18.5	1100	30.0	1178	32.1	414	11.3	3668	74.0
Partial Mid Head	4	22.2	3	16.7	7	38.9	3	16.7	1	5.6	18	0.4
Primary Partial	**597**	**12.0**	**1011**	**20.4**	**1479**	**29.8**	**1406**	**28.4**	**463**	**9.3**	**4956**	**100.0**
Total Resurfacing	27	17.2	52	33.1	64	40.8	13	8.3	1	0.6	157	1.0
Total Conventional	378	5.0	1645	21.8	3222	42.6	2085	27.6	230	3.0	7560	49.4
Total Reverse	103	1.4	582	7.8	2466	33.3	3440	46.4	825	11.1	7416	48.5
Total Mid Head	13	7.5	36	20.8	80	46.2	39	22.5	5	2.9	173	1.1
Primary Total	**521**	**3.4**	**2315**	**15.1**	**5832**	**38.1**	**5577**	**36.4**	**1061**	**6.9**	**15306**	**100.0**
Revision	**188**	**8.2**	**472**	**20.7**	**829**	**36.3**	**639**	**28.0**	**154**	**6.7**	**2282**	**100.0**
TOTAL	**1306**	**5.8**	**3798**	**16.8**	**8140**	**36.1**	**7622**	**33.8**	**1678**	**7.4**	**22544**	**100.0**

Table S3: All Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	14231	63.1	13	102	74	73.0	9.4
Male	8313	36.9	14	96	69	68.3	10.9
TOTAL	**22544**	**100.0**	**13**	**102**	**72**	**71.3**	**10.2**

Figure S1: All Shoulder Replacement by Age and Gender

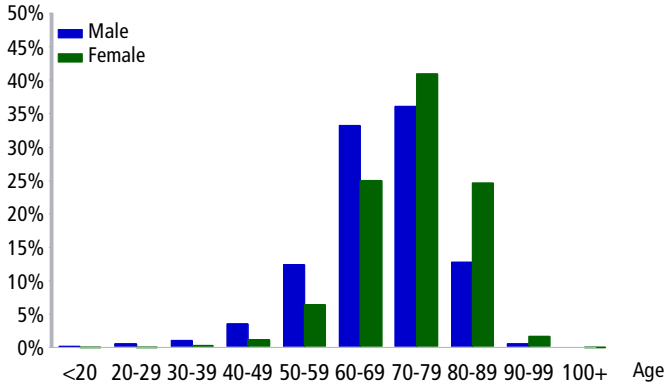


Table S4: Time between Procedures for Bilateral Primary Shoulder Replacement

Bilateral Procedures	<3 months		3months-6months		≥6months		TOTAL	
	N	%	N	%	N	%	N	%
Both Partial	25	1.6	15	1.0	98	6.3	138	8.8
Both Total	44	2.8	161	10.3	1093	69.8	1298	82.9
Total/Partial	2	0.1	9	0.6	119	7.6	130	8.3
TOTAL	**71**	**4.5**	**185**	**11.8**	**1310**	**83.7**	**1566**	**100.0**

Figure S2: Proportion of Shoulder Replacements by Hospital Sector

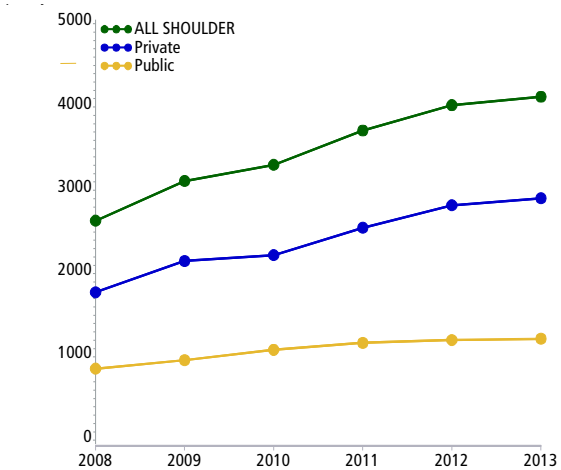
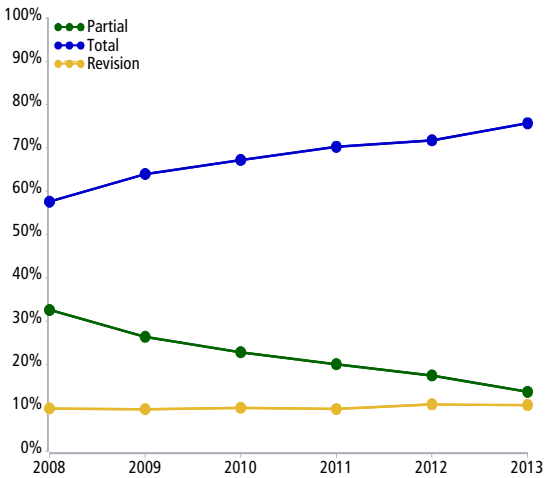


Figure S3: Proportion of Shoulder Replacements



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. **Partial mid head** includes resection of part of the humeral head and replacement with a cone stemmed humeral head prosthesis.
4. **Stemmed hemi shoulder** includes the resection of the humeral head and replacement with a stemmed humeral prosthesis and humeral head prosthesis.

This year partial mid-head replacement is included for the first time. Prior to 2013 only one procedure had been reported to the Registry.

Use of Partial Shoulder Replacement

There have been 4,956 primary partial shoulder procedures reported to the Registry with a procedure date up to and including 31 December 2013. This is an increase of 621 procedures compared to the last Report.

Primary partial shoulder arthroplasty is more common in females (66.2%) with a median age of 73 years for females and 65 years for males. Fracture/dislocation is the principal diagnosis (48.4%) followed by osteoarthritis (40.1%) (Tables SP1 and SP2 and Figure SP1).

Partial resurfacing accounts for 2.3% of all partial shoulder replacements, hemi resurfacing (23.3%) and stemmed hemi arthroplasty (74.0%) (Table S1). The new category of Partial mid head arthroplasty has been used in 0.4% of all partial shoulder procedures. The proportion of hemi resurfacing procedures declined from 25.5% in 2012 to 19.9% in 2013. In the same period stemmed hemi procedures increased from 73.2 % to 76.1% and partial resurfacing from 1.3% to 2.7% (Figure SP2).

Of the 116 partial resurfacing procedures reported to the Registry, two have been revised. The six year cumulative percent revision of primary stemmed hemi arthroplasty and hemi resurfacing is 8.0% and 13.1% respectively. Hemi resurfacing has a lower rate of revision in the first 1.5 years, however after 2.5 years the rate of revision is over three times higher than stemmed hemi arthroplasty. Primary partial mid head prostheses have only been used in 18 procedures, one of which has been revised (Tables SP3 and SP4 and Figure SP3).

Table SP1: Primary Partial Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	3279	66.2	13	101	73	72.2	10.9
Male	1677	33.8	14	93	65	63.3	14.0
TOTAL	**4956**	**100.0**	**13**	**101**	**70**	**69.2**	**12.8**

Figure SP1: Primary Partial Shoulder Replacement by Age and Gender

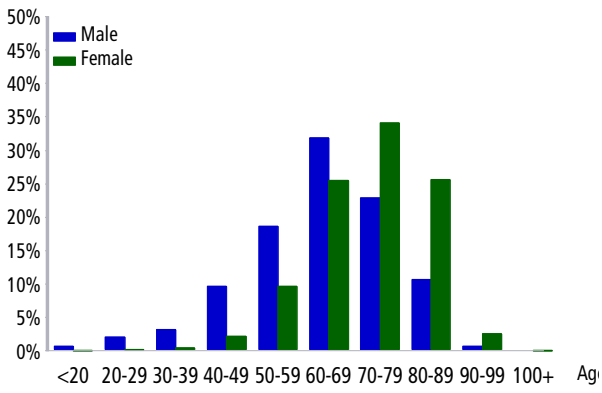


Table SP2: Primary Partial Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Fracture/Dislocation	2397	48.4
Osteoarthritis	1985	40.1
Rotator Cuff Arthropathy	232	4.7
Osteonecrosis	138	2.8
Rheumatoid Arthritis	90	1.8
Tumour	79	1.6
Other Inflammatory Arthritis	18	0.4
Hill-Sachs Defect	13	0.3
Osteochondritis Dissecans	2	0.0
Other	2	0.0
TOTAL	**4956**	**100.0**

Figure SP2: Proportion of Primary Partial Shoulder Replacement by Shoulder Class

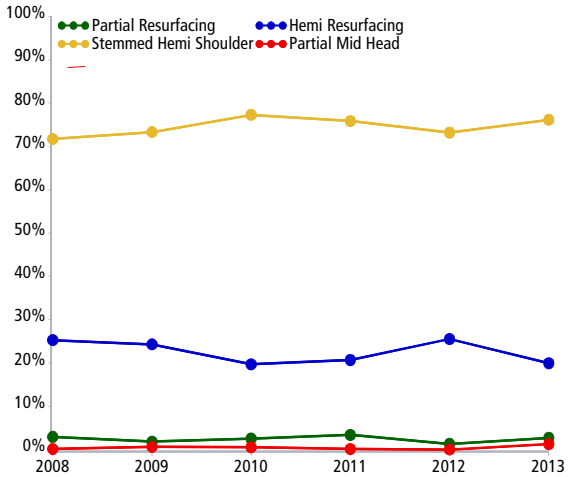


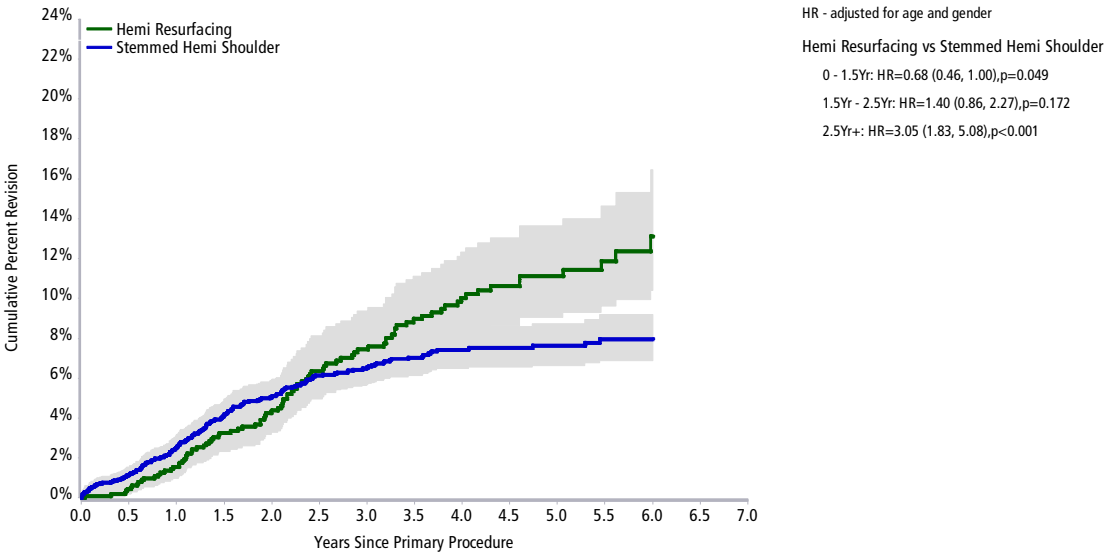
Table SP3: Revision Rates of Primary Partial Shoulder Replacement by Shoulder Class

Shoulder Class	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Partial Resurfacing	2	116	399	0.50 (0.06, 1.81)
Hemi Resurfacing	94	1154	3949	2.38 (1.92, 2.91)
Partial Mid Head	1	18	44	2.27 (0.06, 12.65)
Stemmed Hemi Shoulder	211	3668	11154	1.89 (1.65, 2.16)
All Partial Shoulder	**308**	**4956**	**15546**	**1.98 (1.77, 2.22)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Partial Resurfacing	1.0 (0.1, 6.8)	2.0 (0.5, 7.8)	2.0 (0.5, 7.8)	2.0 (0.5, 7.8)			
Hemi Resurfacing	1.6 (1.0, 2.5)	4.4 (3.3, 5.8)	7.4 (5.9, 9.4)	10.0 (8.1, 12.3)	11.1 (9.0, 13.6)	13.1 (10.4, 16.4)	
Partial Mid Head	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	10.0 (1.5, 52.7)	10.0 (1.5, 52.7)			
Stemmed Hemi Shoulder	2.6 (2.1, 3.2)	5.1 (4.4, 6.0)	6.5 (5.7, 7.5)	7.4 (6.5, 8.5)	7.6 (6.6, 8.7)	8.0 (6.9, 9.2)	
All Partial Shoulder	**2.3 (1.9, 2.8)**	**4.9 (4.2, 5.5)**	**6.7 (5.9, 7.5)**	**8.0 (7.1, 9.0)**	**8.4 (7.5, 9.5)**	**9.3 (8.2, 10.5)**	**9.6 (8.4, 11.1)**

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Hemi Resurfacing	1154	1021	816	642	483	298	119	17
Stemmed Hemi Shoulder	3668	3034	2394	1781	1220	705	253	28

Primary Partial Resurfacing Shoulder Replacement

Demographics

Primary partial resurfacing 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).

The principal diagnosis is osteoarthritis (46.6%) followed by fracture/dislocation (34.5%) (Tables SP6 and SP7).

There have been two revisions of primary partial resurfacing. These were both revised to a total conventional shoulder due to glenoid erosion. In males it is more commonly used in the sequelae of trauma, Hill Sachs or fracture/dislocation (49.5%) compared to females (33.3%) where it is used in osteoarthritis (59.3%).

Table SP5: Primary Partial Resurfacing Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	27	23.3	32	88	67	63.9	16.6
Male	89	76.7	15	87	38	41.1	18.4
TOTAL	**116**	**100.0**	**15**	**88**	**46**	**46.4**	**20.3**

Figure SP4: Primary Partial Resurfacing Shoulder Replacement by Age and Gender

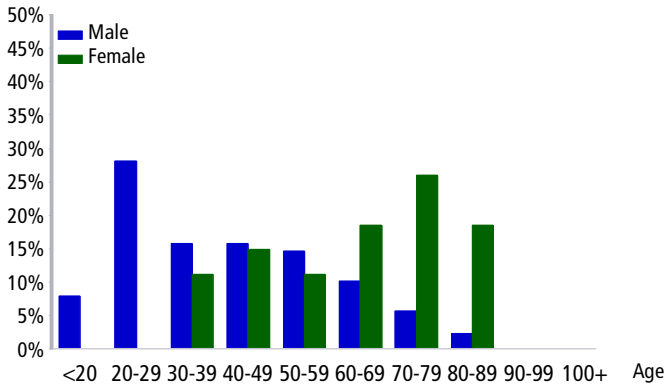


Table SP6: Primary Partial Resurfacing Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	54	46.6
Fracture/Dislocation	40	34.5
Hill-Sachs Defect	13	11.2
Osteonecrosis	4	3.4
Osteochondritis Dissecans	2	1.7
Rotator Cuff Arthropathy	2	1.7
Tumour	1	0.9
TOTAL	**116**	**100.0**

Table SP7: Primary Partial Resurfacing Shoulder Replacement by Primary Diagnosis and Gender

	Male		Female	
Primary Diagnosis	N	Col%	N	Col%
Osteoarthritis	38	42.7	16	59.3
Fracture/Dislocation	33	37.1	7	25.9
Hill-Sachs Defect	11	12.4	2	7.4
Osteonecrosis	2	2.2	2	7.4
Osteochondritis Dissecans	2	2.2	.	.
Rotator Cuff Arthropathy	2	2.2	.	.
Tumour	1	1.1	.	.
TOTAL	89	100.0	27	100.0

Primary Hemi Resurfacing Shoulder Replacement

Demographics

There have been 1,154 primary hemi resurfacing shoulder reported to the Registry up to and including 31 December 2013.

This procedure is undertaken more commonly in males (55.5%). The median age for males is 63 years and for females is 69 years (Table SP8 and Figure SP5).

This procedure is most commonly undertaken for osteoarthritis (86.5%) (Table SP9). The use of primary hemi resurfacing has declined 48.8% since 2008.

The most used prostheses in 2013 were the Copeland followed by PyroTITAN and Global CAP (Table SP10).

Table SP8: Primary Hemi Resurfacing Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	514	44.5	27	93	69	68.7	11.1
Male	640	55.5	19	90	63	61.9	11.9
TOTAL	**1154**	**100.0**	**19**	**93**	**66**	**64.9**	**12.0**

Figure SP5: Primary Hemi Resurfacing Shoulder Replacement by Age and Gender

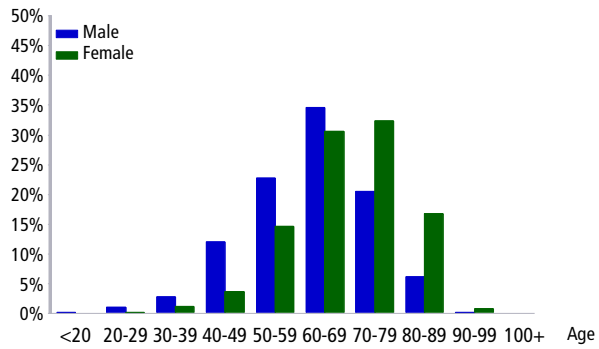


Table SP9: Primary Hemi Resurfacing Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	998	86.5
Rotator Cuff Arthropathy	74	6.4
Osteonecrosis	29	2.5
Fracture/Dislocation	27	2.3
Rheumatoid Arthritis	19	1.6
Other Inflammatory Arthritis	7	0.6
TOTAL	**1154**	**100.0**

Table SP10: Most Used Humeral Head Prostheses in Primary Hemi Resurfacing Shoulder Replacement

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
124	Copeland	113	Copeland	80	Copeland	54	Copeland	80	PyroTITAN	33	Copeland
45	Global CAP	36	Global CAP	25	SMR	38	PyroTITAN	45	Copeland	32	PyroTITAN
34	SMR	27	SMR	19	Aequalis	35	SMR	21	SMR	19	Global CAP
11	Aequalis	21	Aequalis	14	Global CAP	12	Aequalis	19	Global CAP	14	SMR
2	Epoca RH	3	Epoca RH	10	PyroTITAN	12	Global CAP	11	Aequalis	13	Aequalis
1	Buechel-Pappas			1	Epoca RH	3	Epoca RH				
Most Used											
217	(6) 100.0%	200	(5) 100.0%	149	(6) 100.0%	154	(6) 100.0%	176	(5) 100.0%	111	(5) 100.0%

Outcome by Patient Characteristics

Reason for Revision

The main reasons for revision of hemi resurfacing procedures are glenoid erosion (25.5%), pain (23.4%) and rotator cuff insufficiency (18.1%) (Table SP11).

Type of Revision

The most common type of revision is to a total shoulder replacement (88.3%) (Table SP12).

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. (Tables SP13 and SP14 and Figure SP6).

Gender is not a risk factor for revision. (Tables SP15 and SP16 and Figure SP7).

The outcomes of the most commonly used prostheses are listed in Tables SP17 and SP18.

Table SP11: Reason for Revision of Primary Hemi Resurfacing Shoulder Replacement

Reason for Revision	Number	Percent
Glenoid Erosion	24	25.5
Pain	22	23.4
Rotator Cuff Insufficiency	17	18.1
Loosening/Lysis	12	12.8
Instability/Dislocation	12	12.8
Infection	2	2.1
Malposition	2	2.1
Implant Breakage Humeral	2	2.1
Arthrofibrosis	1	1.1
TOTAL	94	100.0

Table SP12: Type of Revision of Primary Hemi Resurfacing Shoulder Replacement

Type of Revision	Number	Percent
Humeral/Glenoid	83	88.3
Glenoid Component	5	5.3
Humeral Component	4	4.3
Removal of Prostheses	1	1.1
Reoperation	1	1.1
TOTAL	94	100.0

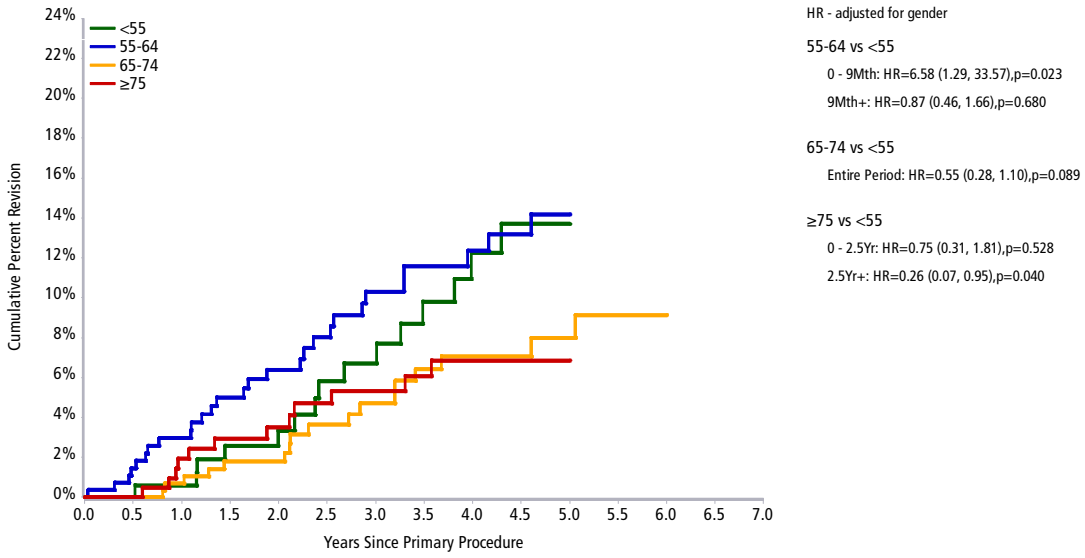
Table SP13: Revision Rates of Primary Hemi Resurfacing Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	17	175	603	2.82 (1.64, 4.51)
55-64	29	281	936	3.10 (2.07, 4.45)
65-74	17	319	1088	1.56 (0.91, 2.50)
≥75	12	223	804	1.49 (0.77, 2.61)
TOTAL	75	998	3431	**2.19 (1.72, 2.74)**

Table SP14: Yearly Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Age (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	0.6 (0.1, 4.1)	3.3 (1.4, 7.9)	6.7 (3.5, 12.6)	12.3 (7.3, 20.2)	13.7 (8.3, 22.1)		
55-64	3.0 (1.5, 5.8)	6.4 (4.0, 10.3)	10.3 (6.9, 15.2)	12.3 (8.5, 17.8)	14.2 (9.8, 20.3)		
65-74	0.7 (0.2, 2.7)	1.8 (0.8, 4.3)	4.7 (2.6, 8.4)	7.1 (4.3, 11.6)	8.0 (4.9, 13.0)	9.1 (5.6, 14.8)	
≥75	1.9 (0.7, 5.0)	3.5 (1.7, 7.2)	5.3 (2.9, 9.7)	6.9 (3.9, 11.9)	6.9 (3.9, 11.9)		

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	175	156	127	96	67	46	23	3
55-64	281	246	188	148	115	71	28	6
65-74	319	279	224	173	132	82	40	4
≥75	223	200	166	138	107	66	18	1

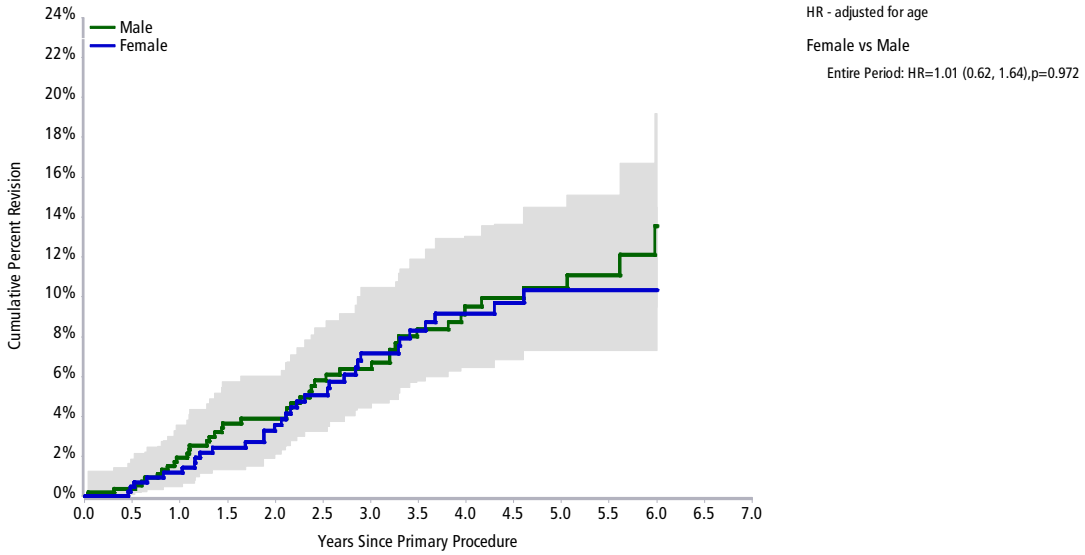
Table SP15: Revision Rates of Primary Hemi Resurfacing Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	43	555	1861	2.31 (1.67, 3.11)
Female	32	443	1570	2.04 (1.39, 2.88)
TOTAL	**75**	**998**	**3431**	**2.19 (1.72, 2.74)**

Table SP16: Yearly Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Gender (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	1.9 (1.0, 3.6)	3.9 (2.5, 6.0)	6.4 (4.4, 9.2)	9.5 (6.9, 13.0)	10.5 (7.6, 14.2)	13.5 (9.5, 19.2)	
Female	1.2 (0.5, 2.8)	3.6 (2.1, 6.0)	7.2 (4.9, 10.5)	9.1 (6.4, 12.9)	10.3 (7.3, 14.5)	10.3 (7.3, 14.5)	

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	555	481	372	299	229	146	60	8
Female	443	400	333	256	192	119	49	6

Table SP17: Revision Rates of Primary Hemi Resurfacing Shoulder Replacement by Humeral Head

Humeral Head	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	7	87	254	2.75 (1.11, 5.67)
Copeland	47	520	1959	2.40 (1.76, 3.19)
Global CAP	17	188	752	2.26 (1.32, 3.62)
PyroTITAN	7	160	257	2.73 (1.10, 5.62)
SMR	12	175	614	1.95 (1.01, 3.41)
Other (2)	4	24	113	3.54 (0.96, 9.05)
TOTAL	**94**	**1154**	**3949**	**2.38 (1.92, 2.91)**

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

Table SP18: Yearly Cumulative Percent Revision of Primary Hemi Resurfacing Shoulder Replacement by Humeral Head

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Aequalis	1.3 (0.2, 8.9)	6.0 (2.3, 15.2)	11.1 (5.4, 21.9)	11.1 (5.4, 21.9)	11.1 (5.4, 21.9)		
Copeland	1.6 (0.8, 3.2)	4.6 (3.0, 6.9)	7.1 (5.0, 9.9)	10.3 (7.7, 13.8)	11.5 (8.7, 15.2)	12.5 (9.3, 16.8)	
Global CAP	0.6 (0.1, 4.1)	3.1 (1.3, 7.3)	8.0 (4.6, 13.7)	10.4 (6.4, 16.7)	11.3 (7.1, 17.9)		
PyroTITAN	3.3 (1.4, 7.8)	5.1 (2.4, 10.4)					
SMR	0.6 (0.1, 4.2)	3.3 (1.4, 7.7)	4.7 (2.3, 9.7)	6.9 (3.6, 13.0)	8.5 (4.5, 15.9)		
Other (2)	4.2 (0.6, 26.1)	4.2 (0.6, 26.1)	12.5 (4.2, 33.9)	12.5 (4.2, 33.9)	12.5 (4.2, 33.9)	20.5 (7.7, 48.0)	

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

Primary Partial Mid Head Shoulder Replacement

Demographics and Outcome

There have been 18 primary partial mid head shoulder procedures reported to the Registry up to and including 31 December 2013.

This procedure is undertaken more commonly in females (55.6%). The median age for females is 67 years and for males is 64 years (Table SP19 and Figure SP8). This procedure is most commonly undertaken for osteoarthritis (72.2%) (Table SP20).

There has been one revision of primary partial mid head shoulder replacement. This was revised to a stemmed hemi shoulder due to fracture after 2.7 years.

Table SP19: Primary Partial Mid Head Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	10	55.6	51	85	67	67.6	9.4
Male	8	44.4	46	83	64	63.1	14.2
TOTAL	**18**	**100.0**	**46**	**85**	**67**	**65.6**	**11.6**

Figure SP8: Primary Partial Mid Head Shoulder Replacement by Age and Gender

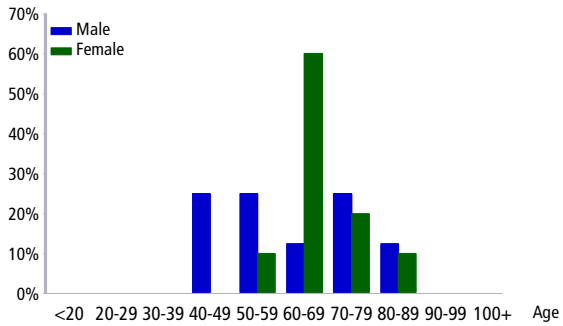


Table SP20: Primary Partial Mid Head Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	13	72.2
Osteonecrosis	3	16.7
Fracture/Dislocation	2	11.1
TOTAL	**18**	**100.0**

Primary Stemmed Hemi Shoulder Replacement

Demographics

There have been 3,668 primary stemmed hemi arthroplasty procedures recorded by the Registry up to and including 31 December 2013. This procedure is most common in females (74.4%). The median age for females is 74 years and 67 years for males (Table SP21 and Figure SP9).

The principal diagnosis is fracture/dislocation (63.5%) followed by osteoarthritis (25.1%) (Table SP22 and SP23). The proportion of primary stemmed hemi shoulder procedures undertaken for fracture/dislocation decreased slightly from 70.1% in 2012 to 68.4% in 2013. In the same period, there was a small increase in stemmed hemiarthroplasty for osteoarthritis, from 18.2% to 20.5% (Figure SP10).

The most common humeral stem prostheses remain unchanged in 2013; SMR followed by Global FX and Aequalis (Table SP24). The 10 most used stem prostheses accounted for 93.2% of all primary stemmed hemi procedures in 2013. This has decreased from 97.2% in 2008.

The most common humeral head prostheses in 2013 are the SMR followed by Global Advantage and Aequalis. (Table SP25). The 10 most used humeral head prostheses accounted for 89.9% of all primary stemmed hemi procedures in 2013. This has decreased from 98.2% in 2008.

Table SP21: Primary Stemmed Hemi Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	2728	74.4	13	101	74	72.9	10.7
Male	940	25.6	14	93	67	66.3	12.8
TOTAL	**3668**	**100.0**	**13**	**101**	**72**	**71.2**	**11.6**

Figure SP9: Primary Stemmed Hemi Shoulder Replacement by Age and Gender

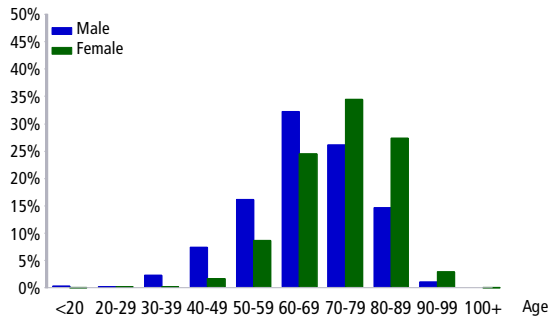


Table SP22: Primary Stemmed Hemi Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Fracture/Dislocation	2328	63.5
Osteoarthritis	920	25.1
Rotator Cuff Arthropathy	156	4.3
Osteonecrosis	102	2.8
Tumour	78	2.1
Rheumatoid Arthritis	71	1.9
Other Inflammatory Arthritis	11	0.3
Other	2	0.1
TOTAL	**3668**	**100.0**

Table SP23: Primary Stemmed Hemi Shoulder Replacement by Primary Diagnosis and Gender

	Male		Female	
Primary Diagnosis	N	Col%	N	Col%
Fracture/Dislocation	483	51.4	1845	67.6
Osteoarthritis	320	34.0	600	22.0
Rotator Cuff Arthropathy	51	5.4	105	3.8
Osteonecrosis	34	3.6	68	2.5
Tumour	40	4.3	38	1.4
Rheumatoid Arthritis	7	0.7	64	2.3
Other Inflammatory Arthritis	5	0.5	6	0.2
Other	.	.	2	0.1
TOTAL	940	100.0	2728	100.0

Figure SP10: Primary Stemmed Hemi Shoulder Replacement by Primary Diagnosis

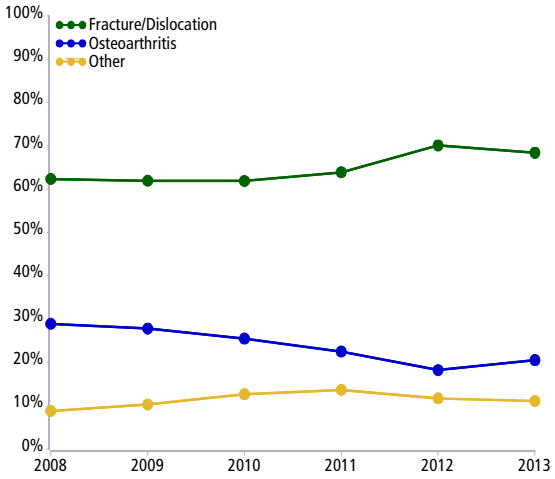


Table SP24: 10 Most Used Humeral Stem Prostheses in Primary Stemmed Hemi Shoulder Replacement

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
207	SMR	219	SMR	215	SMR	187	SMR	174	SMR	119	SMR
138	Global FX	111	Global FX	91	Global FX	105	Aequalis	79	Global FX	66	Global FX
98	Aequalis	72	Aequalis	83	Aequalis	84	Global FX	76	Aequalis	55	Aequalis
81	Global Advantage	65	Global Advantage	77	Bigliani/Flatow TM	60	Bigliani/Flatow TM	47	Bigliani/Flatow TM	42	Global AP
26	Bigliani/Flatow TM	44	Bigliani/Flatow TM	38	Global AP	49	Global AP	35	Global AP	36	Global Unite
13	Solar	28	Global AP	21	Global Advantage	26	Global Advantage	20	Comprehensive	28	Bigliani/Flatow TM
11	Bigliani/Flatow	11	Bigliani/Flatow	13	Solar	13	Comprehensive	19	Global Advantage	24	Comprehensive
11	Bio-Modular	10	Affinis	9	Delta Xtend	7	Solar	15	Global Unite	15	Global Advantage
8	Global AP	9	Delta Xtend	8	Bigliani/Flatow	7	Trabecular Metal	9	Delta Xtend	6	Delta Xtend
6	Univers 3D	7	Solar	7	Comprehensive	6	Mosaic	5	Solar	4	Ascend
10 Most Used											
599 (10)	97.2%	576 (10)	95.4%	562 (10)	96.1%	544 (10)	96.3%	479 (10)	94.9%	395 (10)	93.2%
Remainder											
17 (7)	2.8%	28 (12)	4.6%	23 (10)	3.9%	21 (9)	3.7%	26 (14)	5.1%	29 (13)	6.8%
TOTAL											
616 (17)	100.0%	604 (22)	100.0%	585 (20)	100.0%	565 (19)	100.0%	505 (24)	100.0%	424 (23)	100.0%

Table SP25: 10 Most Used Humeral Head Prostheses in Primary Stemmed Hemi Shoulder Replacement

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
197	Global Advantage	193	SMR	189	SMR	160	SMR	151	SMR	102	SMR
177	SMR	161	Global Advantage	104	Global Advantage	105	Aequalis	93	Global Advantage	71	Global Advantage
98	Aequalis	72	Aequalis	89	Bigliani/Flatow	98	Global Advantage	76	Aequalis	55	Aequalis
38	Bigliani/Flatow	57	Bigliani/Flatow	83	Aequalis	68	Bigliani/Flatow	51	Bigliani/Flatow	36	Global Unite
31	SMR CTA	26	SMR CTA	28	Global AP	29	Global AP	23	SMR CTA	34	Bigliani/Flatow
22	Global Adv CTA	20	Global AP	25	SMR CTA	27	SMR CTA	19	Global AP	26	Global AP
15	Bio-Modular	16	Global Adv CTA	13	Solar	20	Global AP CTA	16	Global AP CTA	17	SMR CTA
13	Solar	10	Affinis	10	Global AP CTA	12	Global Adv CTA	15	Global Unite	16	Global AP CTA
8	Global AP	10	Bio-Modular	9	Bio-Modular	7	Bio-Modular	12	Comprehensive	12	Bio-Modular
6	Univers 3D	9	Delta Xtend	9	Delta Xtend	7	Solar	9	Delta Xtend	12	Comprehensive
10 Most Used											
605 (10)	98.2%	574 (10)	95.0%	559 (10)	95.6%	533 (10)	94.3%	465 (10)	92.1%	381 (10)	89.9%
Remainder											
11 (4)	1.8%	30 (10)	5.0%	26 (10)	4.4%	32 (12)	5.7%	40 (15)	7.9%	43 (14)	10.1%
TOTAL											
616 (14)	100.0%	604 (20)	100.0%	585 (20)	100.0%	565 (22)	100.0%	505 (25)	100.0%	424 (24)	100.0%

Outcome for all Diagnoses - Patient Characteristics

Primary Diagnosis

The outcome of primary stemmed hemi shoulder replacement by primary diagnoses is listed in Tables SP26 and SP27.

There is no difference in the rate of revision when primary stemmed hemi shoulder replacement is performed for fracture/dislocation or osteoarthritis (Tables SP26 and SP27 and Figure SP11).

Reason for Revision

The most common reasons for revision are instability/dislocation (23.2%), rotator cuff insufficiency (19.4%), glenoid erosion (11.8%) and pain (11.4%) (Table SP28).

Reasons for revisions do not vary depending on primary diagnosis with the exception of glenoid erosion which occurs more frequently when the stemmed hemi shoulder replacement is undertaken for osteoarthritis (Table SP29).

Type of Revision

The most common type of revision is total shoulder replacement (61.1%). Glenoid component only revision occurs in 13.7% of procedures (Table SP30).

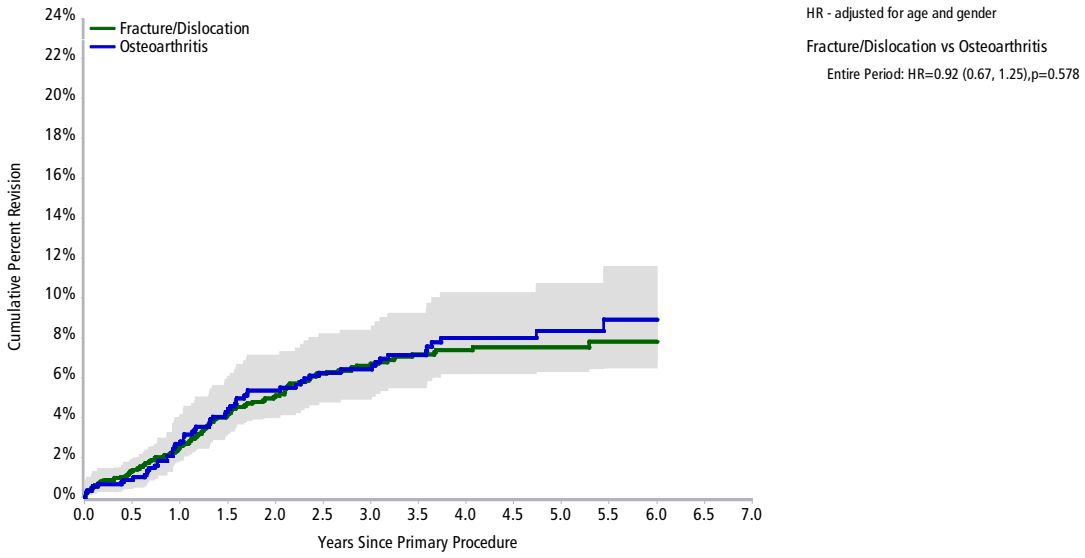
Table SP26: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Fracture/Dislocation	131	2328	6807	1.92 (1.61, 2.28)
Osteoarthritis	61	920	3140	1.94 (1.49, 2.50)
Osteonecrosis	2	102	366	0.55 (0.07, 1.98)
Rheumatoid Arthritis	2	71	268	0.75 (0.09, 2.70)
Rotator Cuff Arthropathy	5	156	434	1.15 (0.37, 2.69)
Tumour	7	78	91	7.67 (3.08, 15.80)
Other Inflammatory Arthritis	3	11	42	7.15 (1.48, 20.91)
Other	0	2	7	0.00 (0.00, 53.98)
TOTAL	211	3668	11154	**1.89 (1.65, 2.16)**

Table SP27: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Primary Diagnosis

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture/Dislocation	2.6 (2.0, 3.3)	5.1 (4.2, 6.2)	6.7 (5.6, 8.0)	7.4 (6.2, 8.8)	7.5 (6.3, 8.9)	7.8 (6.5, 9.3)	
Osteoarthritis	2.8 (1.9, 4.1)	5.4 (4.0, 7.1)	6.4 (4.9, 8.4)	8.0 (6.2, 10.3)	8.3 (6.5, 10.7)	8.9 (6.8, 11.6)	
Osteonecrosis	0.0 (0.0, 0.0)	2.2 (0.5, 8.4)	2.2 (0.5, 8.4)	2.2 (0.5, 8.4)			
Rheumatoid Arthritis	0.0 (0.0, 0.0)	3.1 (0.8, 11.9)	3.1 (0.8, 11.9)	3.1 (0.8, 11.9)	3.1 (0.8, 11.9)	3.1 (0.8, 11.9)	
Rotator Cuff Arthropathy	0.7 (0.1, 4.9)	1.6 (0.4, 6.1)	5.5 (2.2, 13.1)				
Tumour	9.1 (3.8, 20.8)	18.7 (8.4, 38.4)					
Other Inflammatory Arthritis	18.2 (4.9, 55.3)	27.3 (9.7, 62.9)	27.3 (9.7, 62.9)	27.3 (9.7, 62.9)	27.3 (9.7, 62.9)	27.3 (9.7, 62.9)	
Other	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)					

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture/Dislocation	2328	1904	1466	1072	722	399	134	13
Osteoarthritis	920	794	666	530	377	232	86	6

Table SP28: Reason for Revision of Primary Stemmed Hemi Shoulder Replacement

Reason for Revision	Number	Percent
Instability/Dislocation	49	23.2
Rotator Cuff Insufficiency	41	19.4
Glenoid Erosion	26	12.3
Pain	24	11.4
Loosening/Lysis	20	9.5
Fracture	16	7.6
Infection	14	6.6
Arthrofibrosis	9	4.3
Malposition	5	2.4
Dissociation	4	1.9
Incorrect Sizing	1	0.5
Other	2	0.9
TOTAL	211	100.0

Table SP29: Revision Diagnosis of Primary Stemmed Hemi Shoulder Replacement by Primary Diagnosis

	Fracture/Dislocation			Osteoarthritis		
Revision Diagnosis	**Number**	**% Revision**	**% Primary**	**Number**	**% Revision**	**% Primary**
Rotator Cuff Insufficiency	32	24.4	1.4	6	9.8	0.7
Instability/Dislocation	29	22.1	1.2	15	24.6	1.6
Glenoid Erosion	7	5.3	0.3	16	26.2	1.7
Pain	14	10.7	0.6	8	13.1	0.9
Loosening/Lysis	12	9.2	0.5	7	11.5	0.8
Fracture	11	8.4	0.5	4	6.6	0.4
Infection	9	6.9	0.4	2	3.3	0.2
Arthrofibrosis	7	5.3	0.3	1	1.6	0.1
Malposition	4	3.1	0.2	1	1.6	0.1
Dissociation	3	2.3	0.1	1	1.6	0.1
Incorrect Sizing	1	0.8	0.0			
Other	2	1.5	0.1			
N Revision	131	100.0	5.6	61	100.0	6.6
N Primary	2328			920		

Table SP30: Type of Revision of Primary Stemmed Hemi Shoulder Replacement

Type of Revision	Number	Percent
Humeral/Glenoid	129	61.1
Glenoid Component	29	13.7
Humeral Component	24	11.4
Head Only	15	7.1
Cement Spacer	5	2.4
Reoperation	4	1.9
Removal of Prostheses	3	1.4
Minor Components	1	0.5
Cement Only	1	0.5
TOTAL	211	100.0

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

Outcome for Osteoarthritis

Age and Gender

When compared to those aged less than 55 years, there is no significant difference in the rate of revision for those aged 55 to 64 years, 65 to 74 years and 75 years and older. (Table SP31 and SP32 and Figure SP12). Gender is not a risk factor for revision. (Tables SP33 and SP34 and Figure SP13).

Humeral Head

There is no difference in the rate of revision when using a CTA humeral head in a stemmed hemi procedure compared to a standard head when used for osteoarthritis. (Tables SP35 and SP36 and Figure SP14).

The outcomes for the most commonly used prostheses for osteoarthritis are listed in Tables SP37 and SP39.

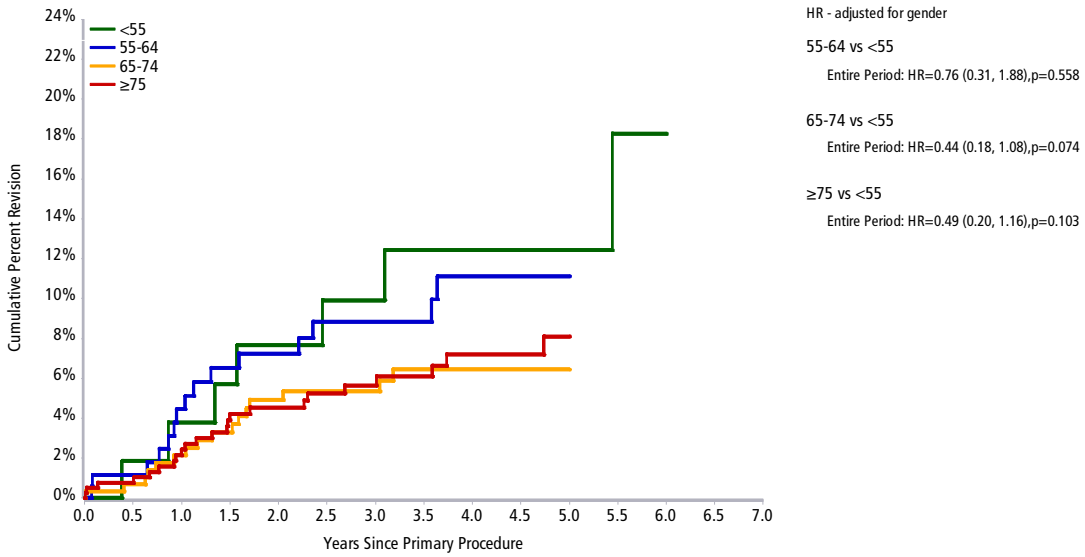
Table SP31: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	7	55	213	3.29 (1.32, 6.77)
55-64	15	173	570	2.63 (1.47, 4.34)
65-74	16	299	1041	1.54 (0.88, 2.50)
≥75	23	393	1316	1.75 (1.11, 2.62)
TOTAL	61	920	3140	**1.94 (1.49, 2.50)**

Table SP32: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Age (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	3.8 (1.0, 14.3)	7.7 (2.9, 19.2)	9.9 (4.2, 22.3)	12.4 (5.7, 25.8)	12.4 (5.7, 25.8)	18.3 (8.2, 37.8)	
55-64	4.5 (2.1, 9.1)	7.2 (4.1, 12.7)	8.8 (5.2, 14.8)	11.1 (6.7, 18.0)	11.1 (6.7, 18.0)		
65-74	2.1 (1.0, 4.7)	4.9 (2.9, 8.3)	5.3 (3.2, 8.9)	6.4 (4.0, 10.4)	6.4 (4.0, 10.4)		
≥75	2.4 (1.3, 4.6)	4.5 (2.8, 7.3)	5.6 (3.6, 8.8)	7.2 (4.7, 10.9)	8.1 (5.3, 12.4)		

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	55	50	44	36	30	18	7	0
55-64	173	143	121	104	64	40	13	2
65-74	299	259	220	179	132	83	27	1
≥75	393	342	281	211	151	91	39	3

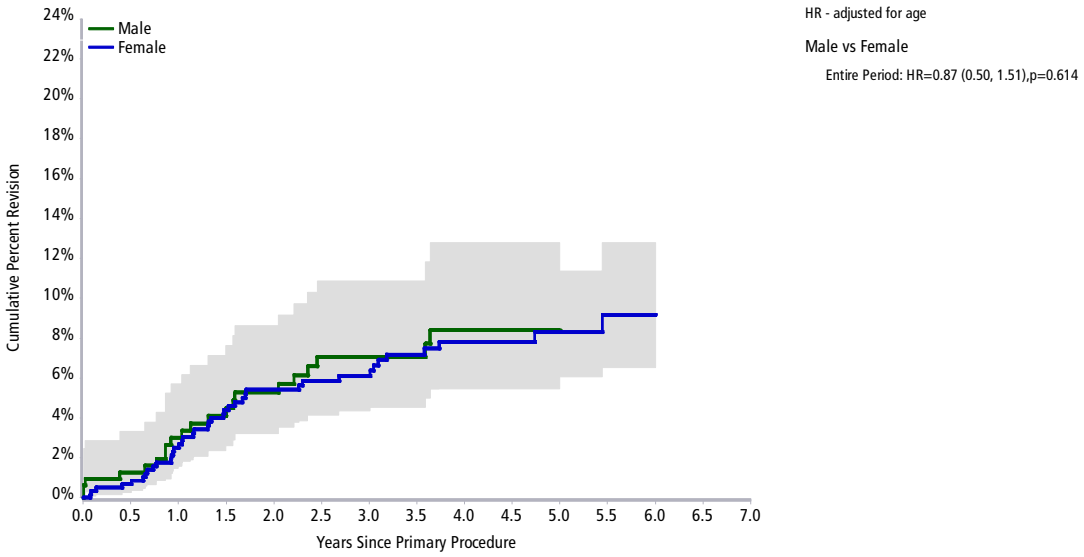
Table SP33: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	21	320	1047	2.01 (1.24, 3.07)
Female	40	600	2093	1.91 (1.37, 2.60)
TOTAL	**61**	**920**	**3140**	**1.94 (1.49, 2.50)**

Table SP34: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Gender (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	3.0 (1.6, 5.7)	5.3 (3.2, 8.6)	7.1 (4.5, 10.9)	8.4 (5.5, 12.8)	8.4 (5.5, 12.8)		
Female	2.7 (1.6, 4.4)	5.4 (3.8, 7.7)	6.1 (4.3, 8.5)	7.8 (5.7, 10.6)	8.3 (6.1, 11.4)	9.2 (6.5, 12.8)	

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	320	272	222	175	119	72	25	3
Female	600	522	444	355	258	160	61	3

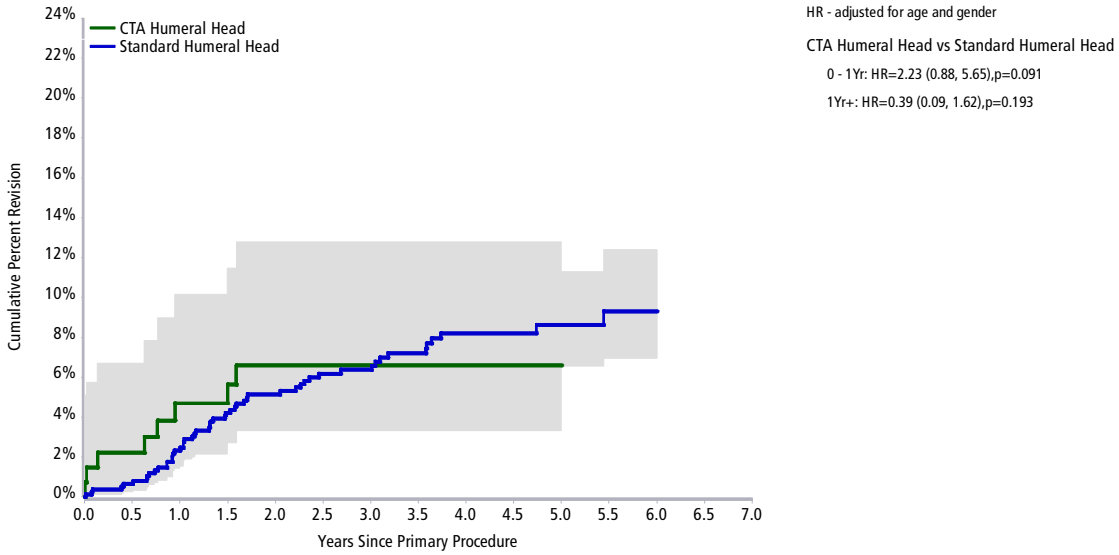
Table SP35: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Head Type (Primary Diagnosis OA)

Head Type	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
CTA Humeral Head	8	136	460	1.74 (0.75, 3.43)
Standard Humeral Head	53	784	2680	1.98 (1.48, 2.59)
TOTAL	**61**	**920**	**3140**	**1.94 (1.49, 2.50)**

Table SP36: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Head Type (Primary Diagnosis OA)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
CTA Humeral Head	4.7 (2.1, 10.2)	6.6 (3.3, 12.8)	6.6 (3.3, 12.8)	6.6 (3.3, 12.8)	6.6 (3.3, 12.8)		
Standard Humeral Head	2.5 (1.6, 3.9)	5.1 (3.7, 7.1)	6.4 (4.8, 8.5)	8.2 (6.3, 10.7)	8.6 (6.6, 11.3)	9.3 (7.0, 12.4)	

Figure SP14: Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Head Type (Primary Diagnosis OA)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
CTA Humeral Head	136	110	90	73	62	41	17	1
Standard Humeral Head	784	684	576	457	315	191	69	5

Table SP37: Revision Rates of Primary Stemmed Hemi 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	123	411	1.22 (0.39, 2.84)
Bigliani/Flatow	Bigliani/Flatow TM	3	43	147	2.05 (0.42, 5.98)
Delta Xtend	Delta Xtend	1	20	52	1.93 (0.05, 10.76)
Global AP	Global AP	5	93	212	2.36 (0.77, 5.51)
Global AP CTA	Global AP	2	30	58	3.46 (0.42, 12.52)
Global Advantage	Global Advantage	9	141	594	1.51 (0.69, 2.88)
Global Advantage	Global FX	3	26	81	3.70 (0.76, 10.83)
Global Advantage CTA	Global Advantage	0	36	169	0.00 (0.00, 2.18)
SMR	SMR	24	248	897	2.68 (1.71, 3.98)
SMR CTA	SMR	5	68	229	2.19 (0.71, 5.10)
Other (21)		4	92	291	1.38 (0.37, 3.52)
TOTAL		61	920	3140	**1.94 (1.49, 2.50)**

Note: Only combinations with over 20 procedures have been listed.

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

Humeral Head	Humeral Stem	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Aequalis	Aequalis	1.8 (0.4, 7.0)	4.8 (2.0, 11.1)	4.8 (2.0, 11.1)	4.8 (2.0, 11.1)			
Bigliani/Flatow	Bigliani/Flatow TM	4.8 (1.2, 17.9)	7.3 (2.4, 21.0)	7.3 (2.4, 21.0)	7.3 (2.4, 21.0)			
Delta Xtend	Delta Xtend	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	10.0 (1.5, 52.7)	10.0 (1.5, 52.7)			
Global AP	Global AP	0.0 (0.0, 0.0)	6.6 (2.5, 16.7)	6.6 (2.5, 16.7)	10.1 (4.0, 23.8)			
Global AP CTA	Global AP	3.3 (0.5, 21.4)	8.7 (2.2, 31.7)	8.7 (2.2, 31.7)				
Global Advantage	Global Advantage	0.7 (0.1, 5.0)	3.0 (1.1, 7.8)	4.6 (2.1, 10.0)	6.6 (3.3, 12.8)	6.6 (3.3, 12.8)		
Global Advantage	Global FX	4.0 (0.6, 25.2)	8.6 (2.2, 30.3)	15.1 (5.0, 41.0)	15.1 (5.0, 41.0)	15.1 (5.0, 41.0)		
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	4.2 (2.3, 7.7)	6.4 (3.9, 10.5)	8.0 (5.1, 12.4)	11.3 (7.6, 16.6)	12.3 (8.3, 18.2)		
SMR CTA	SMR	6.2 (2.4, 15.7)	8.0 (3.4, 18.3)	8.0 (3.4, 18.3)	8.0 (3.4, 18.3)	8.0 (3.4, 18.3)		
Other (21)		3.5 (1.2, 10.6)	5.0 (1.9, 12.7)	5.0 (1.9, 12.7)	5.0 (1.9, 12.7)	5.0 (1.9, 12.7)		

Note: Only combinations with over 20 procedures have been listed.

Outcome for Fracture/Dislocation

Age and Gender

Age is a risk factor for revision of stemmed hemi shoulder replacements undertaken for fracture/dislocation. Patients aged 75 years or older have a lower rate of revision compared to patients aged 55 years or less. (Tables SP39 and SP40 and Figure SP15).

There is no difference in outcome by gender (Tables SP41 and SP42 and Figure SP16).

Humeral Stem

There is no difference in the rate of revision of stemmed hemi shoulder replacement when comparing the use of a fracture humeral stem to all other humeral stems when used for fracture/dislocation (Tables SP43 and SP44 and Figure SP17).

The outcomes of the most commonly used prostheses when used for fracture/dislocation are listed in Tables SP45 and SP46. The outcome of these prostheses separated by fracture and other humeral stems are presented in Tables SP47 to SP50.

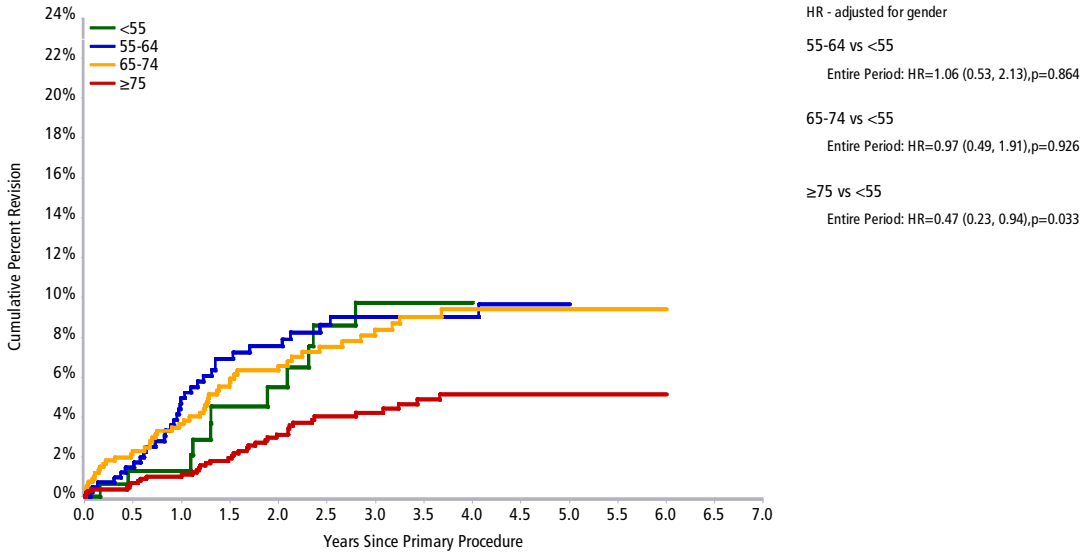
Table SP39: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Age (Primary Diagnosis Fracture/Dislocation)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	11	164	458	2.40 (1.20, 4.30)
55-64	34	427	1289	2.64 (1.83, 3.69)
65-74	48	670	1949	2.46 (1.82, 3.26)
≥75	38	1067	3111	1.22 (0.86, 1.68)
TOTAL	131	2328	6807	**1.92 (1.61, 2.28)**

Table SP40: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Age (Primary Diagnosis Fracture/Dislocation)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	1.3 (0.3, 5.1)	5.5 (2.6, 11.3)	9.7 (5.4, 17.1)	9.7 (5.4, 17.1)			
55-64	5.0 (3.2, 7.7)	7.6 (5.3, 10.8)	9.0 (6.4, 12.5)	9.0 (6.4, 12.5)	9.7 (6.9, 13.5)		
65-74	3.7 (2.4, 5.5)	6.6 (4.8, 8.9)	8.4 (6.3, 11.1)	9.4 (7.1, 12.4)	9.4 (7.1, 12.4)	9.4 (7.1, 12.4)	
≥75	1.1 (0.6, 2.0)	3.1 (2.1, 4.5)	4.2 (3.0, 5.9)	5.1 (3.7, 7.1)	5.1 (3.7, 7.1)	5.1 (3.7, 7.1)	

Figure SP15: Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Age (Primary Diagnosis Fracture/Dislocation)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	164	131	96	72	49	25	10	0
55-64	427	346	277	212	145	87	17	0
65-74	670	540	415	304	205	110	47	8
≥75	1067	887	678	484	323	177	60	5

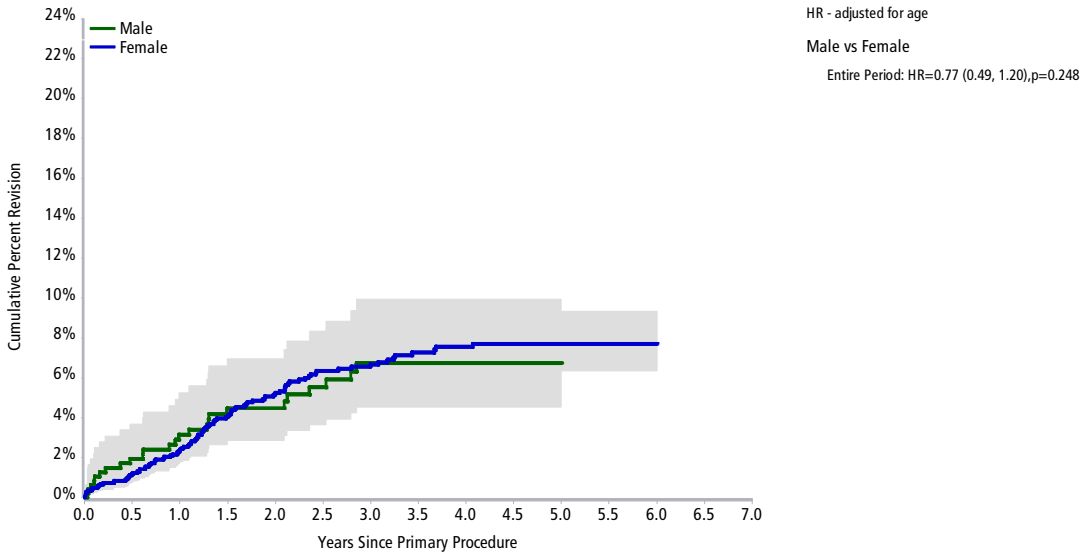
Table SP41: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Gender (Primary Diagnosis Fracture/Dislocation)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	26	483	1385	1.88 (1.23, 2.75)
Female	105	1845	5422	1.94 (1.58, 2.34)
TOTAL	**131**	**2328**	**6807**	**1.92 (1.61, 2.28)**

Table SP42: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Gender (Primary Diagnosis Fracture/Dislocation)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	3.1 (1.9, 5.3)	4.5 (2.9, 7.0)	6.7 (4.5, 9.9)	6.7 (4.5, 9.9)	6.7 (4.5, 9.9)		
Female	2.4 (1.8, 3.3)	5.2 (4.2, 6.5)	6.7 (5.5, 8.1)	7.5 (6.2, 9.1)	7.7 (6.4, 9.3)	7.7 (6.4, 9.3)	

Figure SP16: Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Gender (Primary Diagnosis Fracture/Dislocation)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	483	388	291	214	148	86	27	1
Female	1845	1516	1175	858	574	313	107	12

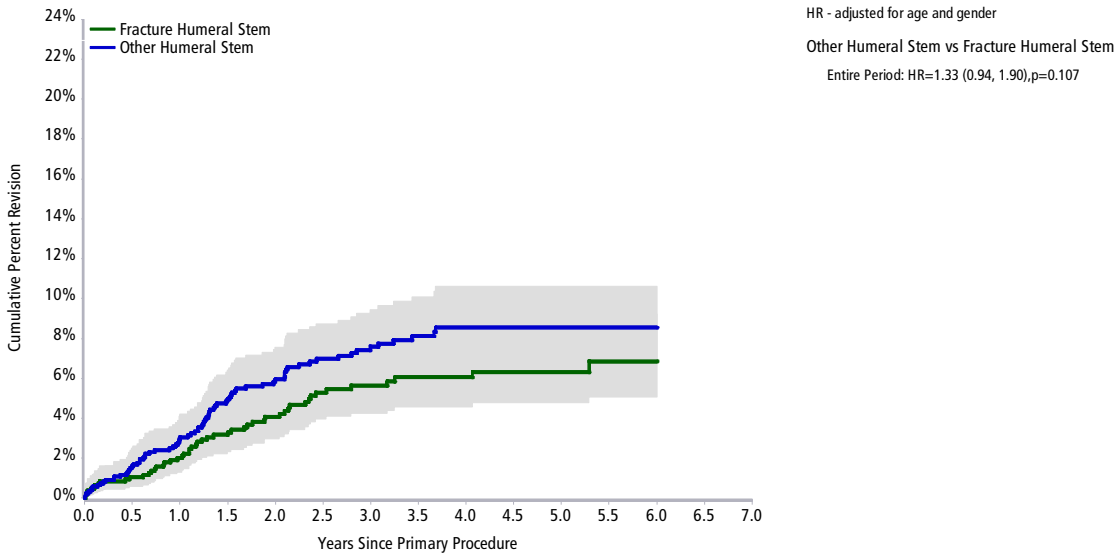
Table SP43: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Stem Type (Primary Diagnosis Fracture/Dislocation)

Fracture	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Fracture Humeral Stem	51	1089	3212	1.59 (1.18, 2.09)
Other Humeral Stem	80	1239	3595	2.23 (1.76, 2.77)
TOTAL	**131**	**2328**	**6807**	**1.92 (1.61, 2.28)**

Table SP44: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Stem Type (Primary Diagnosis Fracture/Dislocation)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture Humeral Stem	2.0 (1.3, 3.1)	4.1 (3.0, 5.6)	5.6 (4.2, 7.5)	6.0 (4.6, 8.0)	6.3 (4.8, 8.3)	6.9 (5.1, 9.2)	
Other Humeral Stem	3.1 (2.2, 4.2)	6.0 (4.7, 7.6)	7.6 (6.1, 9.5)	8.5 (6.9, 10.6)	8.5 (6.9, 10.6)	8.5 (6.9, 10.6)	

Figure SP17: Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Stem Type (Primary Diagnosis Fracture/Dislocation)



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture Humeral Stem	1089	871	683	497	355	211	77	7
Other Humeral Stem	1239	1033	783	575	367	188	57	6

Table SP45: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Humeral Head and Stem (Primary Diagnosis Fracture/Dislocation)

Humeral Head	Humeral Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	13	364	1048	1.24 (0.66, 2.12)
Bigliani/Flatow	Bigliani/Flatow TM	5	243	655	0.76 (0.25, 1.78)
Bio-Modular	Comprehensive	0	45	129	0.00 (0.00, 2.86)
Global Advantage	Global Advantage	8	49	187	4.28 (1.85, 8.43)
Global Advantage	Global FX	37	611	1994	1.86 (1.31, 2.56)
Global Unite	Global Unite	0	49	31	0.00 (0.00, 11.99)
SMR	SMR	56	735	2089	2.68 (2.02, 3.48)
SMR CTA	SMR	2	33	89	2.23 (0.27, 8.07)
Solar	Solar	4	41	129	3.11 (0.85, 7.95)
Other (23)		6	158	457	1.31 (0.48, 2.86)
TOTAL		131	2328	6807	**1.92 (1.61, 2.28)**

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

Table SP46: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Humeral Head and Stem (Primary Diagnosis Fracture/Dislocation)

Humeral Head	Humeral Stem	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Aequalis	Aequalis	2.3 (1.2, 4.6)	3.7 (2.1, 6.4)	4.2 (2.4, 7.2)	4.2 (2.4, 7.2)	4.2 (2.4, 7.2)		
Bigliani/Flatow	Bigliani/Flatow TM	1.4 (0.4, 4.1)	2.4 (1.0, 5.6)	2.4 (1.0, 5.6)	2.4 (1.0, 5.6)			
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	6.2 (2.0, 18.0)	8.3 (3.2, 20.7)	15.9 (7.9, 30.8)	18.8 (9.8, 34.5)	18.8 (9.8, 34.5)		
Global Advantage	Global FX	2.1 (1.2, 3.7)	4.6 (3.1, 6.8)	6.8 (4.8, 9.4)	7.4 (5.3, 10.2)	7.8 (5.6, 10.7)	8.5 (6.1, 12.0)	
Global Unite	Global Unite	0.0 (0.0, 0.0)						
SMR	SMR	3.2 (2.1, 4.9)	7.3 (5.5, 9.7)	8.9 (6.8, 11.6)	10.3 (7.9, 13.3)	10.3 (7.9, 13.3)		
SMR CTA	SMR	3.4 (0.5, 22.1)	3.4 (0.5, 22.1)	8.5 (2.1, 30.8)	8.5 (2.1, 30.8)			
Solar	Solar	7.7 (2.5, 22.0)	10.6 (4.1, 25.8)	10.6 (4.1, 25.8)	10.6 (4.1, 25.8)	10.6 (4.1, 25.8)		
Other (23)		2.2 (0.7, 6.8)	4.0 (1.7, 9.3)	5.2 (2.3, 11.3)	5.2 (2.3, 11.3)			

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

Table SP47: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Humeral Head and Fracture Stem (Primary Diagnosis Fracture/Dislocation)

Humeral Head	Fracture Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	12	345	983	1.22 (0.63, 2.13)
Affinis	Affinis	2	14	27	7.51 (0.91, 27.12)
Anatomical Shoulder	Anatomical Shoulder	0	1	0	0.00 (0.00, 1684)
Bio-Modular	Comprehensive	0	45	129	0.00 (0.00, 2.86)
Comprehensive	Comprehensive	0	17	23	0.00 (0.00, 15.93)
Global Advantage	Global FX	37	611	1994	1.86 (1.31, 2.56)
Global Advantage CTA	Global FX	0	7	26	0.00 (0.00, 14.33)
Global Unite	Global Unite	0	49	31	0.00 (0.00, 11.99)
TOTAL		51	1089	3212	**1.59 (1.18, 2.09)**

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

Humeral Head	Fracture Stem	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Aequalis	Aequalis	2.1 (1.0, 4.4)	3.6 (2.0, 6.4)	4.1 (2.3, 7.2)	4.1 (2.3, 7.2)	4.1 (2.3, 7.2)		
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	2.1 (1.2, 3.7)	4.6 (3.1, 6.8)	6.8 (4.8, 9.4)	7.4 (5.3, 10.2)	7.8 (5.6, 10.7)	8.5 (6.1, 12.0)	
Global Unite	Global Unite	0.0 (0.0, 0.0)						
Other (4)		3.7 (0.5, 23.5)	7.7 (2.0, 27.5)	7.7 (2.0, 27.5)	7.7 (2.0, 27.5)			

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

Table SP49: Revision Rates of Primary Stemmed Hemi Shoulder Replacement by Humeral Head and Other Humeral Stem (Primary Diagnosis Fracture/Dislocation)

Humeral Head	Other Humeral Stem	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Bigliani/Flatow	Bigliani/Flatow TM	5	243	655	0.76 (0.25, 1.78)
Global Advantage	Global Advantage	8	49	187	4.28 (1.85, 8.43)
SMR	SMR	56	735	2089	2.68 (2.02, 3.48)
SMR CTA	SMR	2	33	89	2.23 (0.27, 8.07)
Solar	Solar	4	41	129	3.11 (0.85, 7.95)
Other (22)		5	138	445	1.12 (0.36, 2.62)
TOTAL		80	1239	3595	**2.23 (1.76, 2.77)**

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

Table SP50: Yearly Cumulative Percent Revision of Primary Stemmed Hemi Shoulder Replacement by Humeral Head and Other Humeral Stem (Primary Diagnosis Fracture/Dislocation)

Humeral Head	Other Humeral Stem	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Bigliani/Flatow	Bigliani/Flatow TM	1.4 (0.4, 4.1)	2.4 (1.0, 5.6)	2.4 (1.0, 5.6)	2.4 (1.0, 5.6)			
Global Advantage	Global Advantage	6.2 (2.0, 18.0)	8.3 (3.2, 20.7)	15.9 (7.9, 30.8)	18.8 (9.8, 34.5)	18.8 (9.8, 34.5)		
SMR	SMR	3.2 (2.1, 4.9)	7.3 (5.5, 9.7)	8.9 (6.8, 11.6)	10.3 (7.9, 13.3)	10.3 (7.9, 13.3)		
SMR CTA	SMR	3.4 (0.5, 22.1)	3.4 (0.5, 22.1)	8.5 (2.1, 30.8)	8.5 (2.1, 30.8)			
Solar	Solar	7.7 (2.5, 22.0)	10.6 (4.1, 25.8)	10.6 (4.1, 25.8)	10.6 (4.1, 25.8)	10.6 (4.1, 25.8)		
Other (22)		2.4 (0.8, 7.3)	3.4 (1.3, 8.7)	4.5 (1.9, 10.7)	4.5 (1.9, 10.7)			

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

PRIMARY TOTAL SHOULDER REPLACEMENT

Classes of Total Shoulder Replacement

The Registry sub-categorises primary total shoulder replacement into four classes. For the first time total mid-head replacement is included in the report. Previously this was not reported as there were only 73 procedures reported to the Registry prior to 2013.

The four classes of total shoulder replacement are defined as:

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 15,306 total shoulder procedures recorded by the Registry. Most procedures are performed on females (62.8%). The median age is 74 years for females and 71 years for males (Table ST1 and Figure ST1). The principal diagnosis is osteoarthritis (70.5%) followed by rotator cuff arthropathy (16.6%) and fracture/dislocation (8.1%). Rheumatoid arthritis and osteonecrosis account for 2.5% and 1.3% respectively (Table ST2).

The two main classes of primary total shoulder replacement are total conventional (49.4%) and total reverse (48.5%). Total resurfacing and total mid-head replacement are used infrequently (1.0% and 1.1% respectively) (Table S1). The proportion of total shoulder procedures that are total reverse has increased from 43.7% in 2010 to 57.2% in 2013 (Figure ST2).

Only 157 total resurfacing procedures have been reported to the Registry, nine have been revised. The cumulative percent revision at three years is 7.8%. Total mid-head procedures have also been used in small numbers (173) with over half of these implanted in 2013. There have been two revisions and the one year cumulative percent revision is 1.8%.

At seven years the cumulative percent revision for total conventional and total reverse shoulder replacement is 10.1% and 5.8% respectively. Total reverse shoulder replacement has a significantly higher rate of revision compared to total conventional in the first three months. However, after three months, total reverse shoulder replacement has a significantly lower rate of revision (Tables ST3 and 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 third of procedures in their class (total conventional 29.8%, total reverse 35.1%). When the SMR prostheses are excluded, total reverse shoulder replacement continues to have a significantly higher rate of revision in the first three months and a significantly lower rate of revision after this time. The six year cumulative percent revision for total conventional and total reverse shoulder replacement is 5.0% and 4.7% respectively (Tables ST5 and ST6 and Figure ST4). This compares to 8.6% and 5.3% respectively when including the SMR prostheses (Tables ST3 and ST4).

Table ST1: Primary Total Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	9616	62.8	15	102	74	73.6	8.7
Male	5690	37.2	24	96	71	69.9	9.2
TOTAL	**15306**	**100.0**	**15**	**102**	**73**	**72.2**	**9.1**

Figure ST1: Primary Total Shoulder Replacement by Age and Gender

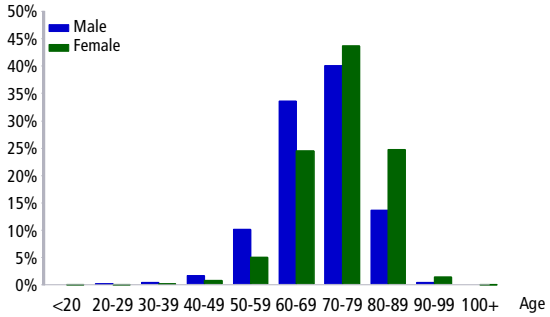


Table ST2: Primary Total Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	10795	70.5
Rotator Cuff Arthropathy	2543	16.6
Fracture/Dislocation	1234	8.1
Rheumatoid Arthritis	375	2.5
Osteonecrosis	192	1.3
Tumour	78	0.5
Other Inflammatory Arthritis	77	0.5
Other	12	0.1
TOTAL	**15306**	**100.0**

Figure ST2: Proportion of Primary Total Shoulder Replacement by Shoulder Class

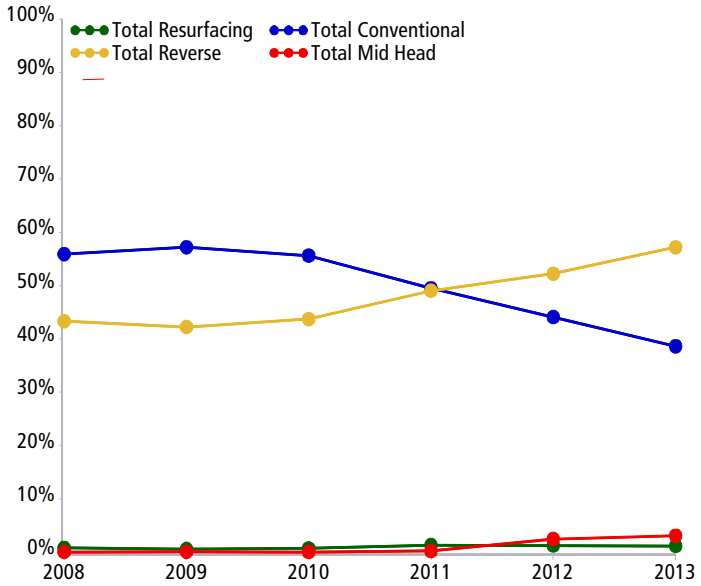


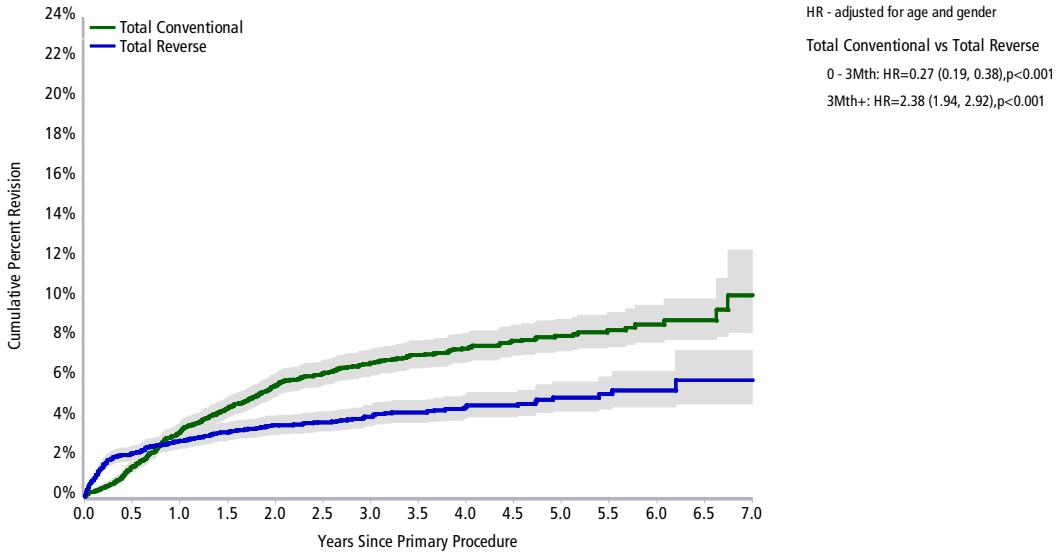
Table ST3: Revision Rates of Primary Total Shoulder Replacement by Shoulder Class

Shoulder Class	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Total Resurfacing	9	157	381	2.36 (1.08, 4.49)
Total Mid Head	2	173	160	1.25 (0.15, 4.50)
Total Conventional	446	7560	21840	2.04 (1.86, 2.24)
Total Reverse	260	7416	17624	1.48 (1.30, 1.67)
All Total Shoulder	**717**	**15306**	**40005**	**1.79 (1.66, 1.93)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Total Resurfacing	2.8 (1.1, 7.5)	5.8 (2.8, 12.0)	7.8 (3.7, 15.9)				
Total Mid Head	1.8 (0.5, 7.1)						
Total Conventional	3.2 (2.8, 3.7)	5.6 (5.0, 6.2)	6.7 (6.1, 7.4)	7.4 (6.8, 8.2)	8.1 (7.3, 8.9)	8.6 (7.7, 9.6)	10.1 (8.2, 12.3)
Total Reverse	2.8 (2.4, 3.2)	3.6 (3.1, 4.0)	4.0 (3.5, 4.6)	4.5 (3.9, 5.1)	5.0 (4.3, 5.7)	5.3 (4.5, 6.3)	5.8 (4.6, 7.3)
All Total Shoulder	**3.0 (2.8, 3.3)**	**4.7 (4.3, 5.0)**	**5.5 (5.1, 6.0)**	**6.2 (5.7, 6.6)**	**6.7 (6.2, 7.3)**	**7.2 (6.6, 7.9)**	**8.3 (7.0, 9.8)**

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Total Conventional	7560	6073	4667	3403	2266	1210	466	82
Total Reverse	7416	5338	3747	2451	1553	777	276	47

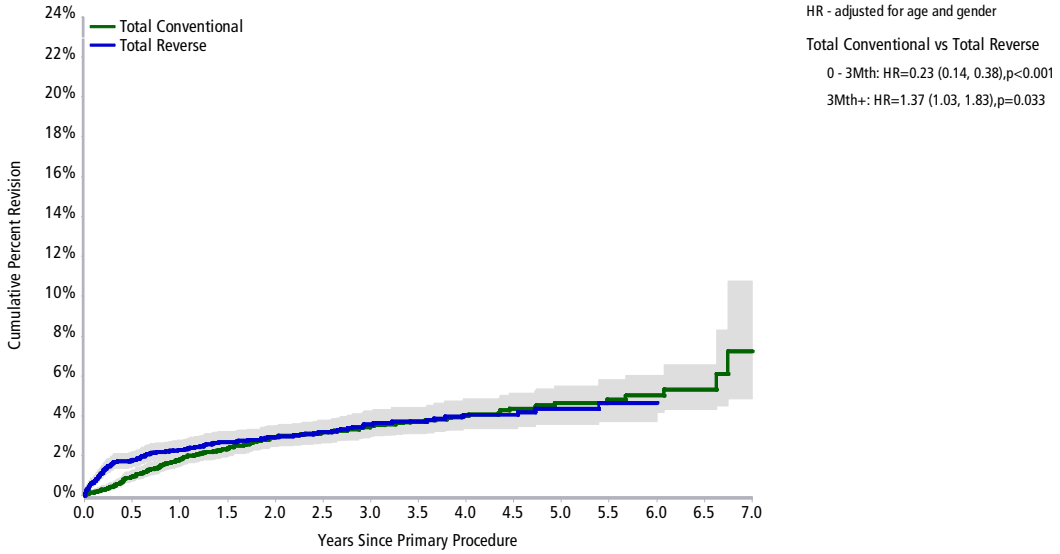
Table ST5: Revision Rates of Primary Total Shoulder Replacement by Shoulder Class (excluding SMR)

Shoulder Class	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Total Conventional	172	5309	15378	1.12 (0.96, 1.30)
Total Reverse	143	4812	11113	1.29 (1.08, 1.52)
TOTAL	**315**	**10121**	**26491**	**1.19 (1.06, 1.33)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Total Conventional	1.8 (1.5, 2.2)	2.9 (2.5, 3.5)	3.5 (3.0, 4.1)	4.0 (3.4, 4.7)	4.6 (3.9, 5.5)	5.0 (4.2, 6.0)	7.2 (4.8, 10.7)
Total Reverse	2.3 (1.9, 2.8)	2.9 (2.5, 3.5)	3.6 (3.0, 4.3)	4.1 (3.4, 4.9)	4.4 (3.6, 5.3)	4.7 (3.7, 5.8)	

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Total Conventional	5309	4291	3296	2406	1594	824	323	59
Total Reverse	4812	3396	2336	1535	964	466	163	31

Primary Total Resurfacing Shoulder Replacement

Demographics

There have been 157 primary total resurfacing procedures recorded by the Registry.

Primary total resurfacing replacement is undertaken more often in males (60.5%). The median age is 68 years for females and 63 years for males (Table ST7 and Figure ST5).

Osteoarthritis is the principal diagnosis (93.6%) (Table ST8).

There were four different types of prostheses used in 2013. The Global CAP remains the most used, accounting for 75.0% of procedures in 2013 (Tables ST9 and ST10).

Table ST7: Primary Total Resurfacing Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	62	39.5	46	86	68	66.4	7.3
Male	95	60.5	35	83	63	61.7	10.1
TOTAL	**157**	**100.0**	**35**	**86**	**64**	**63.5**	**9.4**

Figure ST5: Primary Total Resurfacing Shoulder Replacement by Age and Gender

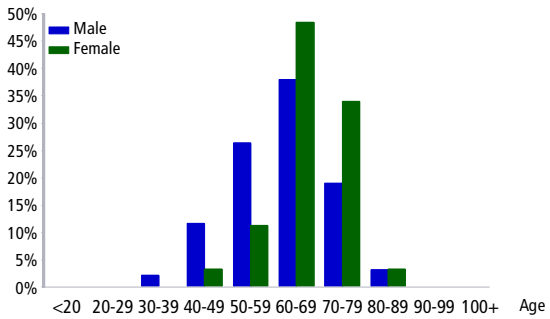


Table ST8: Primary Total Resurfacing Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	147	93.6
Rheumatoid Arthritis	3	1.9
Fracture/Dislocation	3	1.9
Other Inflammatory Arthritis	1	0.6
Rotator Cuff Arthropathy	1	0.6
Osteonecrosis	1	0.6
Other	1	0.6
TOTAL	**157**	**100.0**

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

2008		2009		2010		2011		2012		2013	
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
4	Aequalis	3	SMR	5	SMR	3	SMR	4	Aequalis	5	Aequalis
2	Copeland	2	Copeland	2	Epoca RH	1	Epoca RH	1	SMR	3	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%

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

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
5	SMR	5	Epoca	7	Global	30	Global	31	Global	27	Global
4	Aequalis	3	SMR	5	SMR	3	SMR	4	Aequalis	5	Aequalis
2	Copeland	2	Bio-Modular	2	Epoca	1	Epoca	1	SMR	3	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%

Outcome

There have been nine revisions of primary total resurfacing shoulder replacement. The most common types of revision involve replacing only the humeral component (44.4%) and insert exchange (22.2%) (Table ST11).

The main reasons for revision are instability/dislocation (22.2%), infection (22.2%) and Implant breakage of the glenoid insert (22.2%) (Table ST12).

Table ST11: Type of Revision of Primary Total Resurfacing Shoulder Replacement

Type of Revision	Number	Percent
Humeral Component	4	44.4
Insert Only	2	22.2
Cement Spacer	1	11.1
Head Only	1	11.1
Humeral/Glenoid	1	11.1
TOTAL	**9**	**100.0**

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

Table ST12: Reason for Revision of Primary Total Resurfacing Shoulder Replacement

Reason for Revision	Number	Percent
Instability/Dislocation	2	22.2
Infection	2	22.2
Implant Breakage Glenoid Insert	2	22.2
Loosening/Lysis	1	11.1
Fracture	1	11.1
Implant Breakage Glenoid	1	11.1
TOTAL	**9**	**100.0**

Primary Total Mid Head Shoulder Replacement

Demographics and Outcome

There have been 173 primary total mid head shoulder procedures recorded by the Registry.

Primary total mid head shoulder replacement is undertaken more often in females (53.2%). The median age is 69 years for both females and males (Table ST13 and Figure ST6).

Osteoarthritis is the principal diagnosis (95.4%) (Table ST14).

There have been two revisions of primary total mid head shoulder replacement. One was revised to a stemmed hemi shoulder due to loosening lysis and the other to a reverse shoulder due to instability/dislocation.

The Affinis is the most used mid head shoulder prostheses (Tables ST15 and ST16).

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

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	92	53.2	46	87	69	69.7	8.1
Male	81	46.8	40	89	69	66.7	9.9
TOTAL	**173**	**100.0**	**40**	**89**	**69**	**68.3**	**9.1**

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

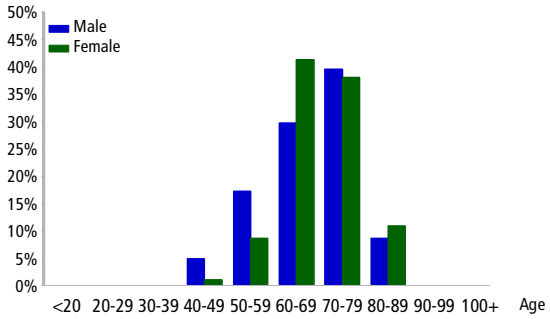


Table ST14: Primary Total Mid Head Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	165	95.4
Osteonecrosis	3	1.7
Rheumatoid Arthritis	3	1.7
Other Inflammatory Arthritis	1	0.6
Other	1	0.6
TOTAL	**173**	**100.0**

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

2011		2012		2013	
N	**Model**	**N**	**Model**	**N**	**Model**
2	Simpliciti	46	Affinis	59	Affinis
2	TESS	25	Simpliciti	34	Simpliciti
1	Affinis			3	Sidus
Most Used					
5	(3) 100.0%	71	(2) 100.0%	96	(3) 100.0%

Note: One additional procedure in 2009 using the Eclipse humeral stem

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

2011		2012		2013	
N	**Model**	**N**	**Model**	**N**	**Model**
2	Aequalis	46	Affinis	59	Affinis
1	Affinis	25	Aequalis	34	Aequalis
1	Comprehensive			2	Bigliani/Flatow TM
1	TESS			1	Bigliani/Flatow
Most Used					
5	(4) 100.0%	71	(2) 100.0%	96	(4) 100.0%

Note: One additional procedure in 2009 using the Univers 3D glenoid

Primary Total Conventional Shoulder Replacement

Demographics

There have been 7,560 total conventional shoulder procedures reported to the Registry. This procedure has declined from 55.8% of all total shoulder replacements in 2008 to 38.6% in 2013 (Figure ST2).

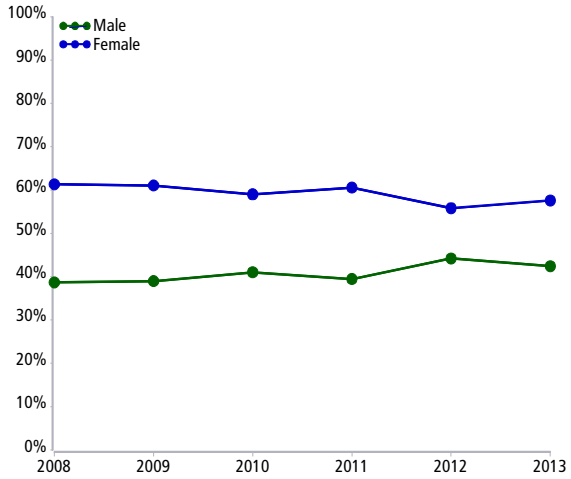
Osteoarthritis is the principal diagnosis, accounting for 93.6% of procedures (Table ST17).

Table ST17: Primary Total Conventional Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	7079	93.6
Rheumatoid Arthritis	171	2.3
Osteonecrosis	108	1.4
Fracture/Dislocation	100	1.3
Other Inflammatory Arthritis	46	0.6
Rotator Cuff Arthropathy	42	0.6
Tumour	8	0.1
Other	6	0.1
TOTAL	**7560**	**100.0**

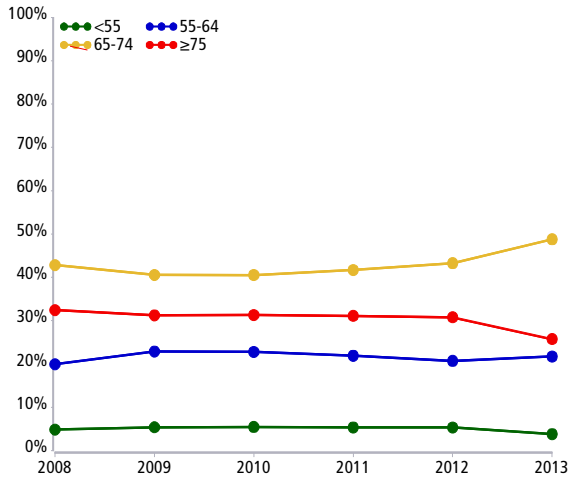
This procedure is most commonly undertaken in females (59.2%). The proportion of males has increased from 38.7% in 2008 to 42.4% in 2013 (Table ST18 and Figure ST7).

Figure ST7: Primary Total Conventional Shoulder Replacement by Gender



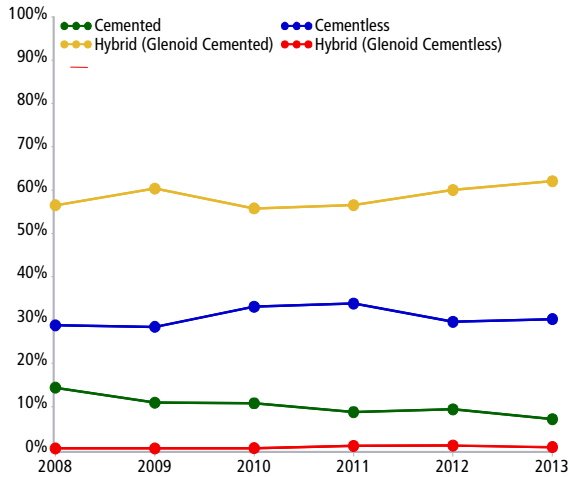
The median age for females is 71 years and 68 years for males (Table ST18). In 2013, 48.8% of patients were aged between 65 and 74 years (Figure ST8).

Figure ST8: Primary Total Conventional Shoulder Replacement by Age



In 2013, the majority of procedures used hybrid fixation (cementless humeral and cemented glenoid) (62%). In 2008 cementless fixation was used in 28.8% of all procedures and its use peaked in 2011 at 33.8%. In 2013 cementless fixation was used in 30.2% of all procedures (Figure ST9).

Figure ST9: Primary Total Conventional Shoulder Replacement by Fixation



The ten most used humeral stem and glenoid components are listed in Tables ST19 and ST20. The Global AP, SMR and Aequalis remain the most commonly used prostheses in 2013.

Table ST18: Primary Total Conventional Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	4479	59.2	23	94	71	71.1	8.6
Male	3081	40.8	26	93	68	67.3	8.9
TOTAL	**7560**	**100.0**	**23**	**94**	**70**	**69.6**	**8.9**

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

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
298	SMR	336	SMR	399	SMR	406	SMR	380	Global AP	357	Global AP
167	Aequalis	301	Global AP	271	Global AP	302	Global AP	337	SMR	321	SMR
117	Global Advantage	211	Aequalis	260	Aequalis	258	Aequalis	233	Aequalis	187	Aequalis
91	Global AP	72	Bigliani/Flatow TM	132	Bigliani/Flatow TM	142	Bigliani/Flatow TM	114	Bigliani/Flatow TM	116	Bigliani/Flatow TM
40	Bigliani/Flatow	43	Global Advantage	65	Global Advantage	44	Affinis	54	Ascend	101	Ascend
37	Bigliani/Flatow TM	40	Bigliani/Flatow	34	Solar	41	Global Advantage	39	Global Advantage	51	Global Advantage
32	Solar	36	Affinis	26	Affinis	19	Solar	29	Solar	22	Equinoxe
27	Affinis	28	Solar	14	Bigliani/Flatow	17	Vaios	22	Comprehensive	19	Comprehensive
11	Univers 3D	23	Trabecular Metal	8	Epoca	13	Comprehensive	17	Vaios	13	Solar
10	Cofield 2	17	Promos	7	Cofield 2	12	Ascend	15	Affinis	7	Turon
10 Most Used											
830 (10)	97.9%	1107 (10)	97.4%	1216 (10)	98.5%	1254 (10)	97.0%	1240 (10)	96.8%	1194 (10)	98.5%
Remainder											
18 (7)	2.1%	30 (7)	2.6%	18 (7)	1.5%	39 (9)	3.0%	41 (6)	3.2%	18 (8)	1.5%
TOTAL											
848 (17)	100.0%	1137 (17)	100.0%	1234 (17)	100.0%	1293 (19)	100.0%	1281 (16)	100.0%	1212 (18)	100.0%

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

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
294	SMR	341	Global	393	SMR	407	SMR	424	Global	395	Global
209	Global	331	SMR	328	Global	344	Global	337	SMR	321	SMR
167	Aequalis	211	Aequalis	263	Aequalis	270	Aequalis	287	Aequalis	288	Aequalis
79	Bigliani/Flatow	101	Bigliani/Flatow	83	Bigliani/Flatow	92	Bigliani/Flatow TM	82	Bigliani/Flatow TM	80	Bigliani/Flatow TM
32	Solar	36	Affinis	66	Bigliani/Flatow TM	58	Bigliani/Flatow	40	Bigliani/Flatow	37	Bigliani/Flatow
27	Affinis	34	Bigliani/Flatow TM	34	Solar	44	Affinis	29	Solar	22	Equinoxe
11	Univers 3D	28	Solar	26	Affinis	19	Solar	22	Comprehensive	19	Comprehensive
10	Cofield 2	17	Promos	9	Global Advantage	16	Vaios	17	Vaios	15	Global Advantage
7	Promos	12	Cofield 2	8	Epoca	12	Comprehensive	15	Affinis	13	Solar
4	Epoca	7	Epoca	7	Cofield 2	11	Epoca	10	Equinoxe	7	Turon
10 Most Used											
840 (10)	99.1%	1118 (10)	98.3%	1217 (10)	98.6%	1273 (10)	98.5%	1263 (10)	98.6%	1197 (10)	98.8%
Remainder											
8 (5)	0.9%	19 (6)	1.7%	17 (6)	1.4%	20 (7)	1.5%	18 (4)	1.4%	15 (5)	1.2%
TOTAL											
848 (15)	100.0%	1137 (16)	100.0%	1234 (16)	100.0%	1293 (17)	100.0%	1281 (14)	100.0%	1212 (15)	100.0%

Outcome by Patient Characteristics

The cumulative percent revision of total conventional shoulder replacement for osteoarthritis is 10.1% at seven years (Tables ST21 and ST22 and Figure ST10).

Reason for Revision

Instability/dislocation is the most common reason for revision of primary total conventional shoulder replacement (27.8%), followed by rotator cuff insufficiency (20.6%) and loosening/lysis (17.5%) (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 of the humeral component (53.6%). This may include the revision of a humeral component and additional minor components (Table ST24). Of the 240 humeral component revisions 201 (83.7%) were revised to a total reverse shoulder replacement. The stem was not revised in 191 (95.0%) procedures.

Age and Gender

Age is a risk factor for revision. Those aged less than 55 years have a higher rate of revision compared to those aged 65 to 74 years and 75 years and older. There is no difference in the rate of revision between those aged less than 55 years and 55 to 64 years. (Tables ST25 and ST26 and Figure ST12). There is no gender difference in the rate of revision (Tables ST27 and ST28 and Figure ST13).

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

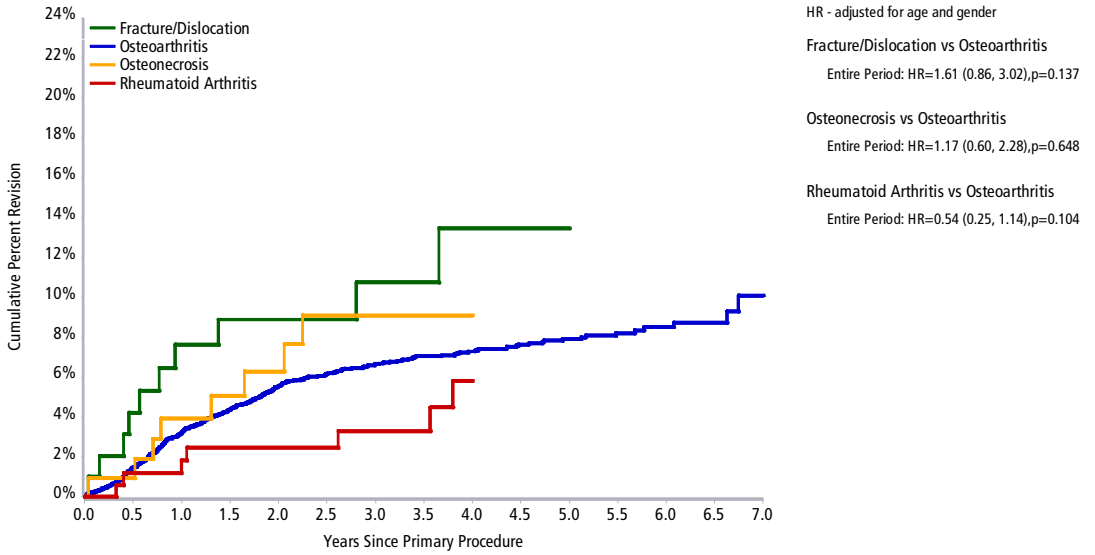
Primary Diagnosis	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Fracture/Dislocation	10	100	284	3.52 (1.69, 6.47)
Osteoarthritis	412	7079	20388	2.02 (1.83, 2.23)
Osteonecrosis	9	108	325	2.77 (1.27, 5.25)
Rheumatoid Arthritis	7	171	578	1.21 (0.49, 2.49)
Other (4)	8	102	265	3.02 (1.31, 5.96)
TOTAL	**446**	**7560**	**21840**	**2.04 (1.86, 2.24)**

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture/Dislocation	7.6 (3.7, 15.4)	8.9 (4.5, 17.0)	10.8 (5.6, 20.0)	13.5 (7.1, 24.7)	13.5 (7.1, 24.7)		
Osteoarthritis	3.2 (2.8, 3.7)	5.6 (5.0, 6.2)	6.7 (6.0, 7.4)	7.3 (6.6, 8.0)	7.9 (7.1, 8.8)	8.5 (7.6, 9.5)	10.1 (8.1, 12.5)
Osteonecrosis	3.9 (1.5, 10.1)	6.3 (2.9, 13.5)	9.1 (4.6, 17.5)	9.1 (4.6, 17.5)			
Rheumatoid Arthritis	1.8 (0.6, 5.6)	2.5 (0.9, 6.4)	3.3 (1.4, 7.8)	5.8 (2.7, 12.3)			
Other (4)	2.3 (0.6, 8.8)	7.9 (3.6, 17.0)					

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture/Dislocation	100	79	62	47	28	12	5	2
Osteoarthritis	7079	5670	4351	3164	2108	1140	439	76
Osteonecrosis	108	93	70	53	40	18	6	1
Rheumatoid Arthritis	171	154	130	101	64	28	9	2

Table ST23: Reason for Revision of Primary Total Conventional Shoulder Replacement

Reason for Revision	Number	Percent
Instability/Dislocation	124	27.8
Rotator Cuff Insufficiency	92	20.6
Loosening/Lysis	78	17.5
Implant Breakage Glenoid Insert	40	9.0
Infection	26	5.8
Dissociation	20	4.5
Incorrect Sizing	13	2.9
Implant Breakage Glenoid	10	2.2
Arthrofibrosis	9	2.0
Pain	9	2.0
Fracture	7	1.6
Metal Sensitivity	5	1.1
Malposition	4	0.9
Wear Glenoid	1	0.2
Wear Glenoid Insert	1	0.2
Other	7	1.6
TOTAL	**446**	**100.0**

Table ST24: Type of Revision of Primary Total Conventional Shoulder Replacement

Type of Revision	Number	Percent
Humeral Component	240	53.8
Humeral/Glenoid	62	13.9
Head Only	55	12.3
Glenoid Component	39	8.7
Head/Insert	27	6.1
Cement Spacer	11	2.5
Removal of Prostheses	6	1.3
Reoperation	3	0.7
Minor Components	2	0.4
Reinsertion of Components	1	0.2
TOTAL	**446**	**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

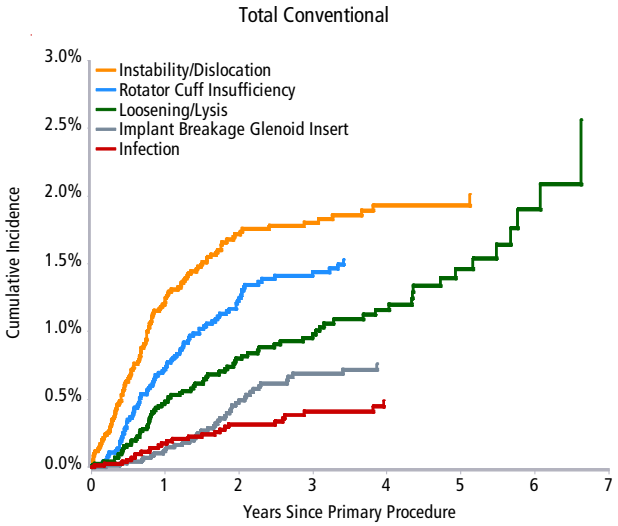


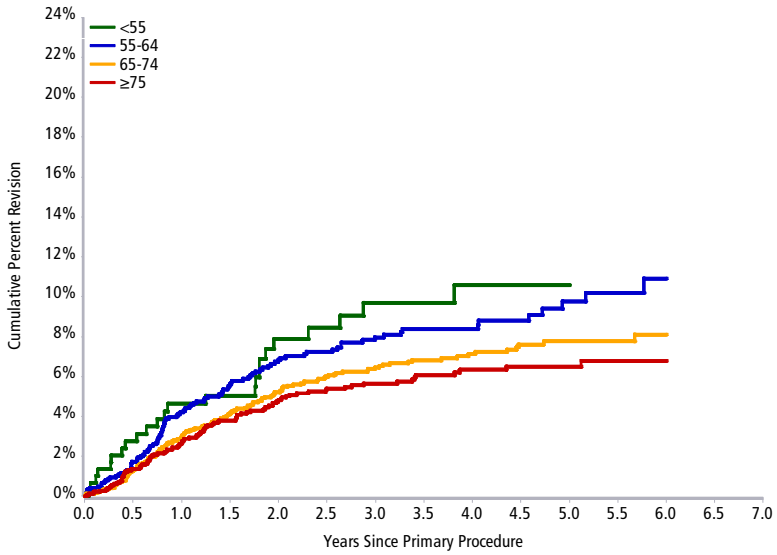
Table ST25: Revision Rates of Primary Total Conventional Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	26	299	882	2.95 (1.93, 4.32)
55-64	109	1517	4393	2.48 (2.04, 2.99)
65-74	167	3055	8626	1.94 (1.65, 2.25)
≥75	110	2208	6487	1.70 (1.39, 2.04)
TOTAL	412	7079	20388	**2.02 (1.83, 2.23)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	4.6 (2.7, 7.8)	7.9 (5.1, 12.0)	9.7 (6.5, 14.4)	10.6 (7.1, 15.7)	10.6 (7.1, 15.7)		
55-64	4.2 (3.3, 5.4)	6.8 (5.6, 8.4)	8.0 (6.6, 9.7)	8.4 (6.9, 10.2)	9.8 (7.9, 12.0)	10.9 (8.6, 13.8)	
65-74	3.0 (2.4, 3.7)	5.2 (4.4, 6.2)	6.4 (5.5, 7.5)	7.1 (6.1, 8.3)	7.8 (6.6, 9.1)	8.1 (6.8, 9.6)	
≥75	2.7 (2.0, 3.5)	4.8 (3.9, 5.9)	5.6 (4.7, 6.8)	6.3 (5.2, 7.7)	6.5 (5.4, 7.9)	6.8 (5.5, 8.3)	

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



HR - adjusted for gender

55-64 vs <55

Entire Period: HR=0.83 (0.54, 1.27),p=0.393

65-74 vs <55

Entire Period: HR=0.64 (0.42, 0.97),p=0.037

≥75 vs <55

Entire Period: HR=0.56 (0.37, 0.87),p=0.009

Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	299	245	185	135	95	54	20	2
55-64	1517	1212	947	692	460	236	100	18
65-74	3055	2399	1824	1321	882	489	178	32
≥75	2208	1814	1395	1016	671	361	141	24

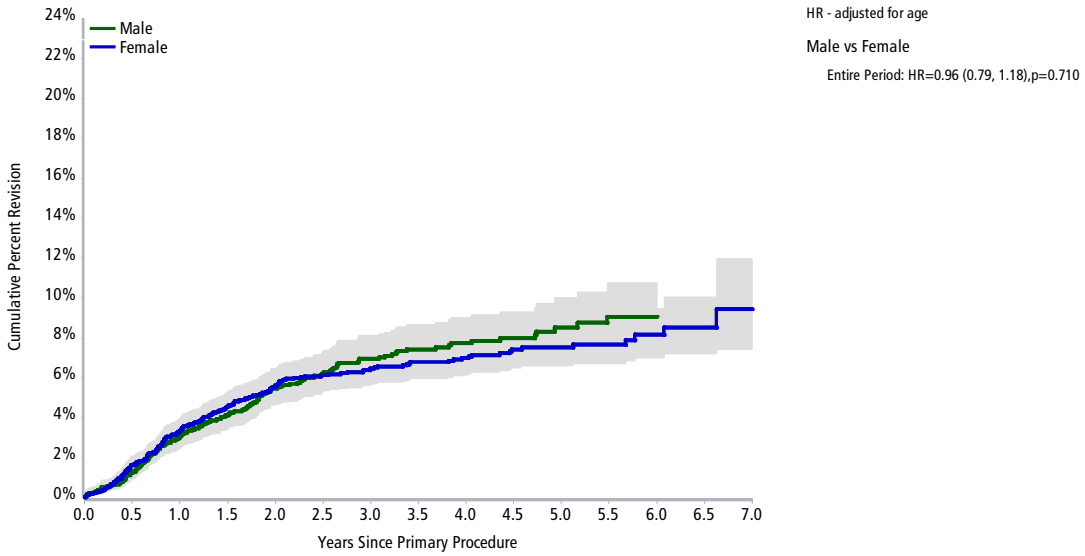
Table ST27: Revision Rates of Primary Total Conventional Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	173	2932	8232	2.10 (1.80, 2.44)
Female	239	4147	12156	1.97 (1.72, 2.23)
TOTAL	**412**	**7079**	**20388**	**2.02 (1.83, 2.23)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	3.1 (2.5, 3.8)	5.5 (4.6, 6.5)	7.0 (5.9, 8.1)	7.7 (6.6, 9.0)	8.5 (7.3, 10.0)	9.1 (7.6, 10.8)	
Female	3.3 (2.8, 4.0)	5.6 (4.9, 6.4)	6.5 (5.7, 7.4)	7.0 (6.1, 8.0)	7.5 (6.6, 8.6)	8.2 (7.0, 9.5)	9.4 (7.4, 12.0)

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	2932	2334	1744	1263	825	440	174	30
Female	4147	3336	2607	1901	1283	700	265	46

Outcome by Prostheses Characteristics

Fixation

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

The fixation analysis was repeated excluding the SMR total conventional prosthesis because it has a higher than anticipated rate of revision and is predominately used with cementless fixation. The outcome of fixation remained the same (Tables ST31 and ST32 and Figure ST15). This indicates that cementless fixation of the glenoid with prostheses other than the SMR is associated with a higher rate of revision.

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 70.0% of total conventional shoulder replacements and has a lower rate of revision compared to both a metal backed glenoid with modular insert and glenoid with a metal backed fixed insert. A glenoid with a modular insert has a higher rate of revision than a glenoid with a metal backed fixed insert (Tables ST33 and ST34 and Figure ST16). The cumulative percent revision at three years is 16.1% for glenoid with modular insert compared to 3.0% for all polyethylene glenoid and 5.2% for glenoid with a metal backed fixed insert. In the glenoid with modular insert revisions 75.2% (190 without stem revised and 10 with stem) retained the metal backed component and replaced the polyethylene with a glenosphere.

The above analysis was repeated excluding the SMR (Tables ST35 and ST 36 and Figure ST17).

A pegged glenoid was used in 90.1% of total conventional shoulder replacements. Cementless pegged glenoids have a higher rate of revision compared to cemented pegged glenoids and cemented keeled glenoids. (Tables ST37 and ST38 and Figure ST18).

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

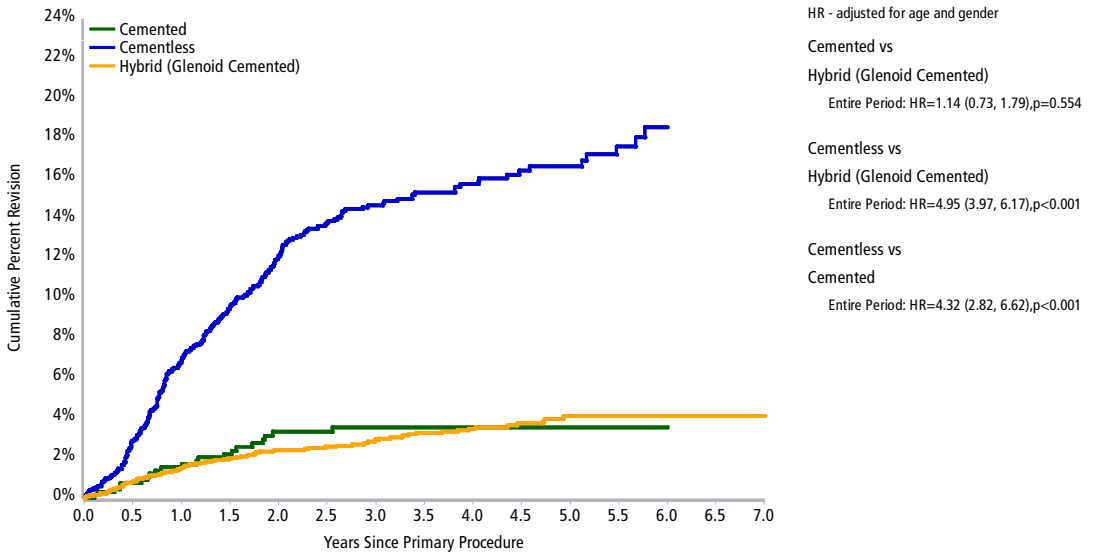
Table ST29: Revision Rates of Primary Total Conventional Shoulder Replacement by Fixation (Primary Diagnosis OA)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	23	694	2322	0.99 (0.63, 1.49)
Cementless	274	2175	5877	4.66 (4.13, 5.25)
Hybrid (Glenoid Cemented)	111	4171	12098	0.92 (0.75, 1.10)
Hybrid (Glenoid Cementless)	4	39	90	4.44 (1.21, 11.38)
TOTAL	412	7079	20388	**2.02 (1.83, 2.23)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Cemented	1.5 (0.8, 2.8)	3.3 (2.1, 5.1)	3.5 (2.3, 5.4)	3.5 (2.3, 5.4)	3.5 (2.3, 5.4)	3.5 (2.3, 5.4)	
Cementless	6.9 (5.9, 8.1)	12.1 (10.7, 13.7)	14.7 (13.1, 16.5)	15.7 (14.0, 17.7)	16.6 (14.8, 18.7)	18.6 (16.1, 21.4)	
Hybrid (Glenoid Cemented)	1.5 (1.2, 1.9)	2.4 (2.0, 3.0)	2.9 (2.4, 3.6)	3.5 (2.8, 4.2)	4.1 (3.3, 5.1)	4.1 (3.3, 5.1)	4.1 (3.3, 5.1)
Hybrid (Glenoid Cementless)	11.0 (4.3, 26.8)	11.0 (4.3, 26.8)	11.0 (4.3, 26.8)	11.0 (4.3, 26.8)			

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Cemented	694	605	487	386	275	166	62	8
Cementless	2175	1681	1255	877	564	307	117	20
Hybrid (Glenoid Cemented)	4171	3354	2589	1890	1263	664	257	48

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

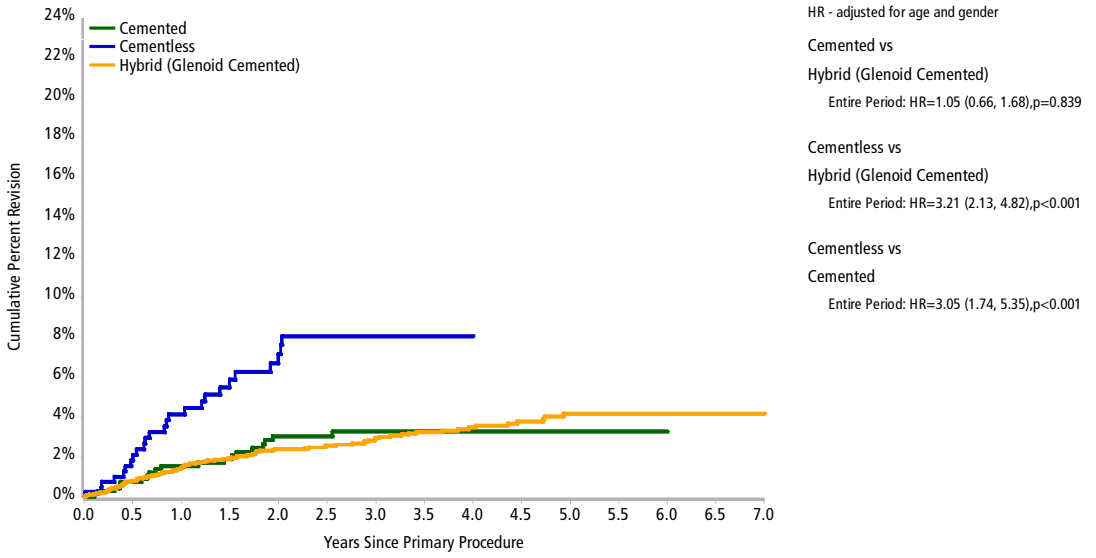
Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	21	682	2289	0.92 (0.57, 1.40)
Cementless	30	403	895	3.35 (2.26, 4.78)
Hybrid (Glenoid Cemented)	103	3873	11112	0.93 (0.76, 1.12)
Hybrid (Glenoid Cementless)	1	12	25	4.00 (0.10, 22.27)
TOTAL	**155**	**4970**	**14321**	**1.08 (0.92, 1.27)**

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Cemented	1.6 (0.8, 2.9)	3.0 (1.9, 4.8)	3.3 (2.1, 5.1)	3.3 (2.1, 5.1)	3.3 (2.1, 5.1)	3.3 (2.1, 5.1)	
Cementless	4.2 (2.5, 6.8)	7.2 (4.8, 10.7)	8.1 (5.5, 11.8)	8.1 (5.5, 11.8)			
Hybrid (Glenoid Cemented)	1.5 (1.1, 1.9)	2.4 (1.9, 3.0)	3.0 (2.4, 3.6)	3.5 (2.8, 4.3)	4.2 (3.4, 5.2)	4.2 (3.4, 5.2)	4.2 (3.4, 5.2)

Note: Excluding hybrid (Glenoid Cementless) as there are only 12 procedures.

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Cemented	682	594	479	381	272	164	62	8
Cementless	403	305	205	107	50	21	12	5
Hybrid (Glenoid Cemented)	3873	3096	2377	1740	1154	585	228	40

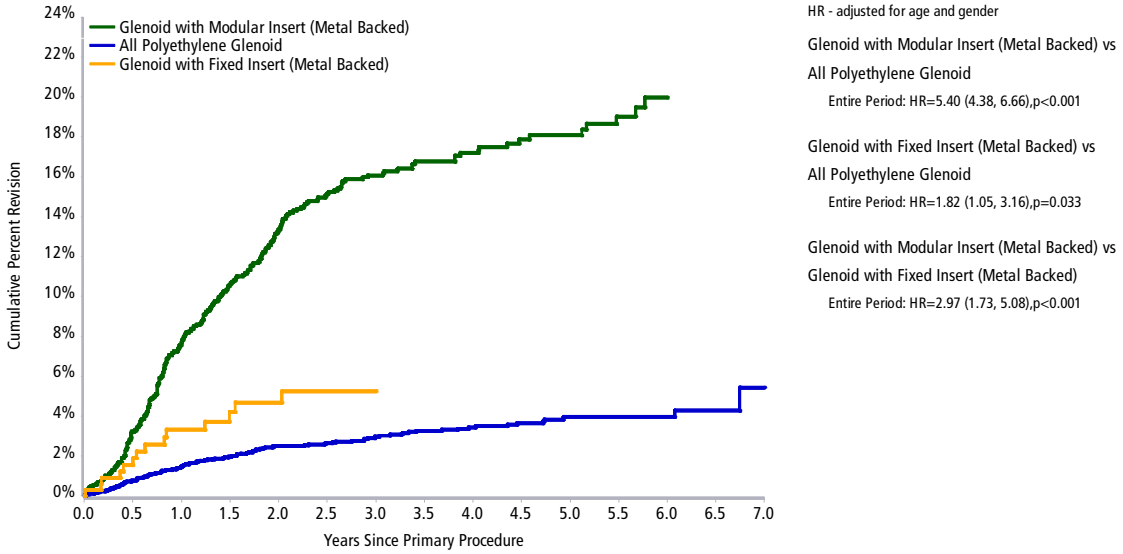
Table ST33: Revision Rates of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA)

Glenoid Type	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Glenoid with Modular Insert (Metal Backed)	266	1884	5294	5.02 (4.44, 5.67)
All Polyethylene Glenoid	132	4858	14405	0.92 (0.77, 1.09)
Glenoid with Fixed Insert (Metal Backed)	14	337	689	2.03 (1.11, 3.41)
TOTAL	**412**	**7079**	**20388**	**2.02 (1.83, 2.23)**

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Glenoid with Modular Insert (Metal Backed)	7.7 (6.5, 9.0)	13.4 (11.8, 15.1)	16.1 (14.3, 18.1)	17.2 (15.3, 19.3)	18.1 (16.1, 20.3)	20.0 (17.5, 22.8)	
All Polyethylene Glenoid	1.5 (1.1, 1.9)	2.5 (2.1, 3.0)	3.0 (2.5, 3.6)	3.4 (2.9, 4.1)	3.9 (3.3, 4.8)	3.9 (3.3, 4.8)	5.4 (3.4, 8.5)
Glenoid with Fixed Insert (Metal Backed)	3.3 (1.8, 6.1)	4.7 (2.7, 8.0)	5.3 (3.1, 8.8)				

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Glenoid with Modular Insert (Metal Backed)	1884	1466	1111	805	543	310	120	20
All Polyethylene Glenoid	4858	3955	3072	2274	1537	830	319	56
Glenoid with Fixed Insert (Metal Backed)	337	249	168	85	28	0	0	0

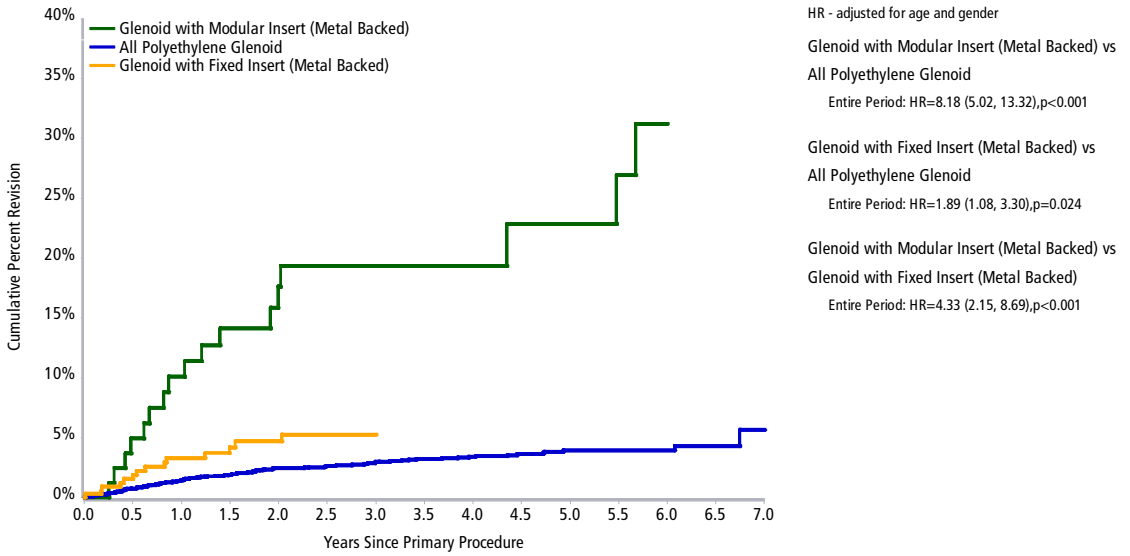
Table ST35: Revision Rates of Primary Total Conventional Shoulder Replacement by Glenoid Type (Primary Diagnosis OA, excluding SMR)

Glenoid Type	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Glenoid with Modular Insert (Metal Backed)	19	84	246	7.73 (4.65, 12.07)
All Polyethylene Glenoid	122	4549	13386	0.91 (0.76, 1.09)
Glenoid with Fixed Insert (Metal Backed)	14	337	689	2.03 (1.11, 3.41)
TOTAL	**155**	**4970**	**14321**	**1.08 (0.92, 1.27)**

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Glenoid with Modular Insert (Metal Backed)	10.1 (5.2, 19.2)	17.6 (10.6, 28.6)	19.4 (11.9, 30.7)	19.4 (11.9, 30.7)	22.9 (13.8, 36.4)	31.2 (19.0, 48.6)	
All Polyethylene Glenoid	1.4 (1.1, 1.9)	2.5 (2.0, 3.0)	3.0 (2.4, 3.6)	3.4 (2.8, 4.1)	4.0 (3.2, 4.8)	4.0 (3.2, 4.8)	5.6 (3.4, 9.2)
Glenoid with Fixed Insert (Metal Backed)	3.3 (1.8, 6.1)	4.7 (2.7, 8.0)	5.3 (3.1, 8.8)				

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Glenoid with Modular Insert (Metal Backed)	84	69	47	27	24	21	12	5
All Polyethylene Glenoid	4549	3686	2852	2119	1425	749	290	48
Glenoid with Fixed Insert (Metal Backed)	337	249	168	85	28	0	0	0

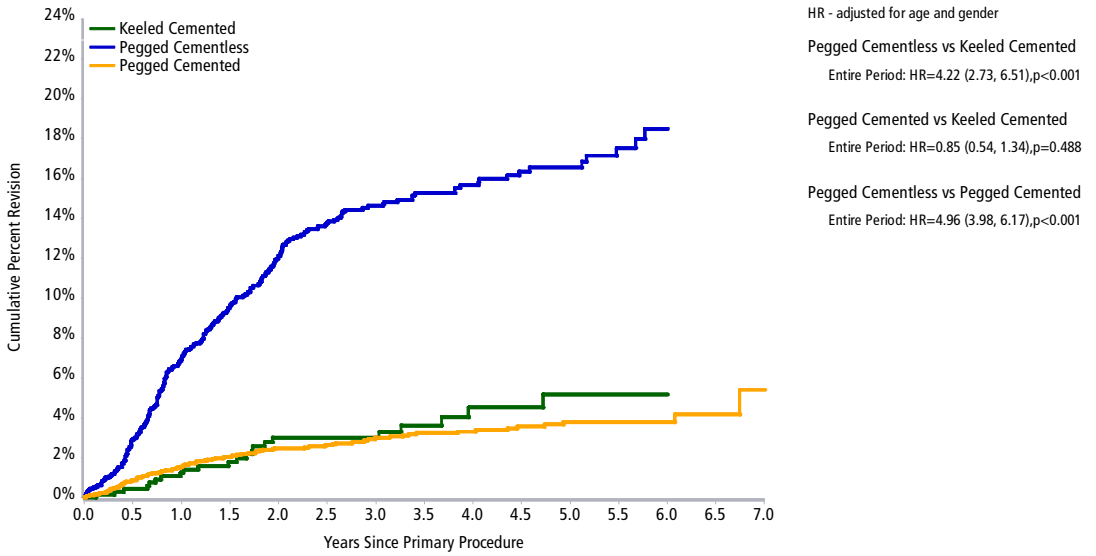
Table ST37: Revision Rates of Primary Total Conventional Shoulder Replacement by Glenoid Design and Fixation (Primary Diagnosis OA)

Glenoid Design	Glenoid Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Keeled	Cemented	22	704	2072	1.06 (0.67, 1.61)
Pegged	Cementless	278	2214	5967	4.66 (4.13, 5.24)
Pegged	Cemented	112	4161	12348	0.91 (0.75, 1.09)
TOTAL		**412**	**7079**	**20388**	**2.02 (1.83, 2.23)**

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

Glenoid Design	Glenoid Fixation	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Keeled	Cemented	1.2 (0.6, 2.5)	3.0 (1.9, 4.8)	3.0 (1.9, 4.8)	4.5 (2.9, 7.1)	5.2 (3.2, 8.2)	5.2 (3.2, 8.2)	
Pegged	Cementless	7.0 (5.9, 8.2)	12.1 (10.7, 13.7)	14.6 (13.0, 16.4)	15.7 (14.0, 17.6)	16.6 (14.7, 18.6)	18.5 (16.1, 21.2)	
Pegged	Cemented	1.5 (1.2, 2.0)	2.5 (2.0, 3.1)	3.0 (2.5, 3.7)	3.3 (2.7, 4.0)	3.8 (3.1, 4.7)	3.8 (3.1, 4.7)	5.4 (3.3, 8.7)

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



Number at Risk	0 Yr	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Keeled Cemented	704	578	445	325	198	122	52	2
Pegged Cementless	2214	1711	1275	888	570	310	120	20
Pegged Cemented	4161	3381	2631	1951	1340	708	267	54

Table ST39: Revision Rates of Primary Total Conventional Shoulder Replacement by Humeral Stem and Glenoid

Humeral Stem	Glenoid	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	33	1377	4081	0.81 (0.56, 1.14)
Affinis	Affinis	7	172	640	1.09 (0.44, 2.25)
Ascend	Aequalis	2	169	160	1.25 (0.15, 4.52)
Bigliani/Flatow	Bigliani/Flatow	5	145	685	0.73 (0.24, 1.70)
Bigliani/Flatow TM	Bigliani/Flatow	12	290	890	1.35 (0.70, 2.36)
Bigliani/Flatow TM	Bigliani/Flatow TM	15	341	693	2.16 (1.21, 3.57)
Comprehensive	Comprehensive	5	58	77	6.49 (2.11, 15.14)
Global AP	Global	37	1689	4071	0.91 (0.64, 1.25)
Global Advantage	Global	20	515	2268	0.88 (0.54, 1.36)
SMR	SMR	274	2247	6449	4.25 (3.76, 4.78)
Solar	Solar	3	179	652	0.46 (0.09, 1.34)
Other (31)		33	378	1174	2.81 (1.94, 3.95)
TOTAL		**446**	**7560**	**21840**	**2.04 (1.86, 2.24)**

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

Humeral Stem	Glenoid	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Aequalis	Aequalis	1.4 (0.9, 2.2)	2.5 (1.7, 3.5)	2.6 (1.8, 3.7)	3.2 (2.2, 4.5)	3.2 (2.2, 4.5)	3.2 (2.2, 4.5)	
Affinis	Affinis	0.0 (0.0, 0.0)	0.7 (0.1, 4.6)	2.1 (0.7, 6.4)	3.3 (1.2, 9.0)			
Ascend	Aequalis	0.8 (0.1, 5.5)						
Bigliani/Flatow	Bigliani/Flatow	2.1 (0.7, 6.3)	2.1 (0.7, 6.3)	3.6 (1.5, 8.4)	3.6 (1.5, 8.4)	3.6 (1.5, 8.4)		
Bigliani/Flatow TM	Bigliani/Flatow	2.6 (1.2, 5.3)	4.3 (2.4, 7.7)	4.3 (2.4, 7.7)	5.1 (2.9, 9.0)	5.1 (2.9, 9.0)		
Bigliani/Flatow TM	Bigliani/Flatow TM	3.2 (1.7, 5.9)	4.6 (2.7, 7.8)	6.0 (3.5, 10.0)				
Comprehensive	Comprehensive	10.1 (4.3, 22.6)	10.1 (4.3, 22.6)					
Global AP	Global	1.6 (1.1, 2.4)	2.4 (1.7, 3.3)	2.7 (1.9, 3.7)	3.0 (2.1, 4.2)	3.0 (2.1, 4.2)		
Global Advantage	Global	1.4 (0.7, 3.0)	2.7 (1.6, 4.6)	3.5 (2.1, 5.6)	3.8 (2.4, 6.0)	4.1 (2.6, 6.5)	4.1 (2.6, 6.5)	
SMR	SMR	6.6 (5.6, 7.7)	11.6 (10.2, 13.1)	14.0 (12.5, 15.7)	15.2 (13.6, 17.1)	15.8 (14.1, 17.7)	16.7 (14.7, 18.9)	
Solar	Solar	0.6 (0.1, 3.9)	0.6 (0.1, 3.9)	0.6 (0.1, 3.9)	1.4 (0.3, 5.8)	3.0 (0.9, 9.9)		
Other (31)		3.5 (2.0, 6.2)	6.7 (4.4, 10.1)	8.4 (5.7, 12.2)	8.9 (6.1, 13.0)	11.3 (7.7, 16.3)		

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

Primary Total Reverse Shoulder Replacement

Demographics

There have been 7,416 total reverse procedures reported to the Registry up to an including 31 December 2013. Primary total reverse shoulder replacement has increased from 43.3% of all total shoulder replacements in 2008 to 57.2% in 2013.

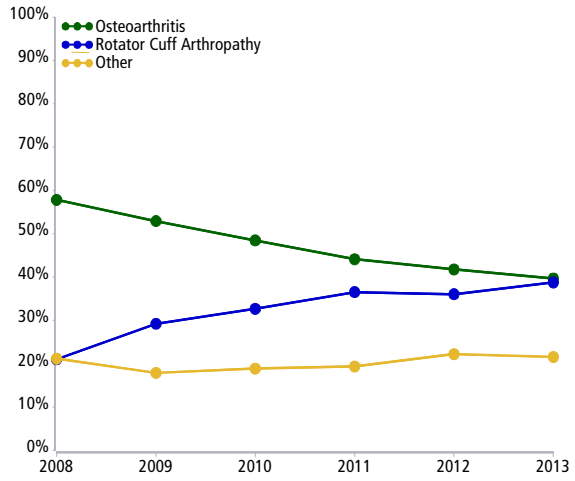
The principal diagnoses are osteoarthritis (45.9%), rotator cuff arthropathy (33.7%) and fracture/dislocation (15.3%) (Table ST41).

Table ST41: Primary Total Reverse Shoulder Replacement by Primary Diagnosis

Primary Diagnosis	Number	Percent
Osteoarthritis	3404	45.9
Rotator Cuff Arthropathy	2500	33.7
Fracture/Dislocation	1131	15.3
Rheumatoid Arthritis	198	2.7
Osteonecrosis	80	1.1
Tumour	70	0.9
Other Inflammatory Arthritis	29	0.4
Other	4	0.1
TOTAL	**7416**	**100.0**

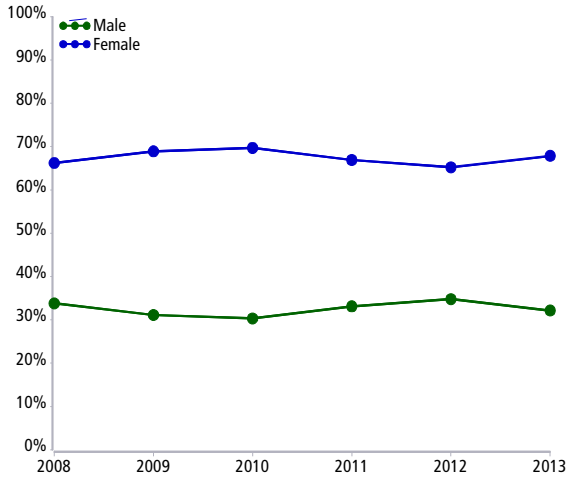
The proportion of total reverse procedures for osteoarthritis has declined from 57.8% in 2008 to 39.7% in 2013. Over the same period, the proportion of procedures for rotator cuff arthropathy has increased from 21.0% to 38.8% (Figure ST19). The diagnosis of rotator cuff arthropathy was added to the procedure form in April 2008.

Figure ST19: Primary Total Reverse Shoulder Replacement by Primary Diagnosis



This procedure is most commonly undertaken in females (67.2%) (Table ST42 and Figure ST20).

Figure ST20: Primary Total Reverse Shoulder Replacement by Gender



The median age for females is 77 years and 74 years for males (Table ST42). The proportion of patients aged 75 years and older has declined from 61.4% in 2010 to 56.2% in 2013 (Figure ST21).

Figure ST21: Primary Total Reverse Shoulder Replacement by Age

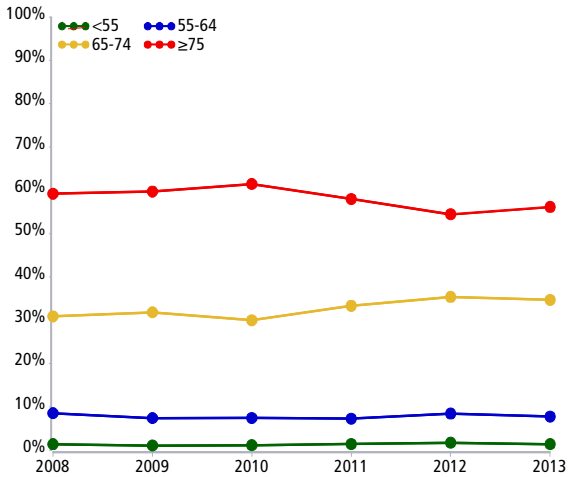


Table ST42: Primary Total Reverse Shoulder Replacement by Age and Gender

Gender	Number	Percent	Minimum	Maximum	Median	Mean	Std Dev
Female	4983	67.2	15	102	77	75.9	8.1
Male	2433	32.8	24	96	74	73.7	8.1
TOTAL	**7416**	**100.0**	**15**	**102**	**76**	**75.2**	**8.2**

The majority of procedures use cementless fixation (73.9% in 2013). Hybrid fixation was used in 25.5% of procedures. There has been little variation in the use of fixation since 2008 (Figure ST22).

The most used humeral stem and glenoid component prostheses are listed in Tables ST43 and ST44. The Delta Xtend, SMR and Aequalis have remained the three most commonly used total reverse prostheses since 2010.

Figure ST22: Primary Total Reverse Shoulder Replacement by Fixation

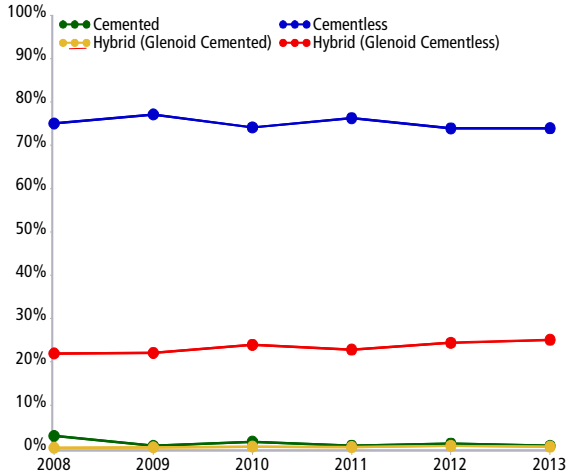


Table ST43: 10 Most Used Humeral Stem Prostheses in Primary Total Reverse Shoulder Replacement

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
262	SMR	320	Delta Xtend	364	SMR	483	SMR	551	Delta Xtend	691	Delta Xtend
252	Delta Xtend	303	SMR	336	Delta Xtend	436	Delta Xtend	508	SMR	540	SMR
76	Aequalis	115	Aequalis	161	Aequalis	205	Aequalis	288	Aequalis	299	Aequalis
42	Trabecular Metal	59	Trabecular Metal	71	Trabecular Metal	108	Trabecular Metal	119	Trabecular Metal	139	Trabecular Metal
21	Delta CTA	32	Promos	20	Promos	15	Comprehensive	16	Comprehensive	35	Comprehensive
2	Custom Made (Lima)	6	Mets	10	Mets	15	Vaios	11	Vaios	35	RSP
1	Generic Stem	3	Delta CTA	4	Comprehensive	14	Mets	9	Equinoxe	14	Equinoxe
1	Promos	1	Generic Stem	3	Delta CTA	3	Promos	8	Mets	13	Global Unite
				1	Affinis	1	Equinoxe	4	Global Unite	11	Affinis
						1	Generic Stem	2	Affinis	7	Vaios
10 Most Used											
657	(8) 100.0%	839	(8) 100.0%	970	(9) 100.0%	1281	(10) 100.0%	1516	(10) 99.9%	1784	(10) 99.4%
Remainder											
0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	2	(2) 0.1%	11	(3) 0.6%
TOTAL											
657	(8) 100.0%	839	(8) 100.0%	970	(9) 100.0%	1281	(10) 100.0%	1518	(12) 100.0%	1795	(13) 100.0%

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

2008		2009		2010		2011		2012		2013	
N	Model	N	Model	N	Model	N	Model	N	Model	N	Model
264	SMR	320	Delta Xtend	364	SMR	483	SMR	555	Delta Xtend	704	Delta Xtend
252	Delta Xtend	304	SMR	336	Delta Xtend	436	Delta Xtend	507	SMR	535	SMR
76	Aequalis	115	Aequalis	161	Aequalis	206	Aequalis	289	Aequalis	304	Aequalis
42	Trabecular Metal	59	Trabecular Metal	71	Trabecular Metal	108	Trabecular Metal	119	Trabecular Metal	141	Trabecular Metal
21	Delta CTA	32	Promos	20	Promos	15	Comprehensive Reverse	16	Comprehensive Reverse	35	Comprehensive Reverse
1	Generic Metaglene	6	Mets	10	Mets	15	Vaios	11	Vaios	35	RSP
1	Promos	3	Delta CTA	4	Comprehensive Reverse	14	Mets	9	Equinoxe	14	Equinoxe
				3	Delta CTA	3	Promos	8	Mets	11	Affinis
				1	Affinis	1	Equinoxe	2	Affinis	7	Vaios
								1	Mutars	6	Mets
10 Most Used											
657	(7) 100.0%	839	(7) 100.0%	970	(9) 100.0%	1281	(9) 100.0%	1517	(10) 99.9%	1792	(10) 99.8%
Remainder											
0	(0) 0%	0	(0) 0%	0	(0) 0%	0	(0) 0%	1	(1) 0.1%	3	(2) 0.2%
TOTAL											
657	(7) 100.0%	839	(7) 100.0%	970	(9) 100.0%	1281	(9) 100.0%	1518	(11) 100.0%	1795	(12) 100.0%

Outcome by Patient Characteristics

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

Reason for Revision

Instability/dislocation is the most common reason for revision (43.5%), followed by loosening/lysis (19.6%), infection (13.1%) and fracture (10.8%) (Table ST47).

Type of Revision

The main types of revision are replacement of both cup (liner) and head (glenosphere) (29.6%), cup only (22.7%), humeral component only (18.1%, this may include the revision of a humeral component and additional minor components) and head only (15.4%) (Table ST48).

Age and Gender

Age is not a risk factor for revision of total reverse shoulder replacement undertaken for osteoarthritis (Tables ST49 and ST50 and Figure ST24). Males have a higher rate of revision (six year cumulative percent revision of 6.9% compared to 4.1% for females) (Tables ST51 and ST52 and Figure ST25).

Males have a higher rate of revision of total reverse shoulder replacement undertaken for rotator cuff arthropathy (five year cumulative percent revision of 7.6% compared to 3.7% for females) (Tables ST53 and ST54 and Figure ST26).

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)
Fracture/Dislocation	37	1131	2401	1.54 (1.08, 2.12)
Osteoarthritis	120	3404	8929	1.34 (1.11, 1.61)
Rheumatoid Arthritis	9	198	503	1.79 (0.82, 3.39)
Rotator Cuff Arthropathy	86	2500	5387	1.60 (1.28, 1.97)
Other (4)	8	183	403	1.98 (0.86, 3.91)
TOTAL	260	7416	17624	**1.48 (1.30, 1.67)**

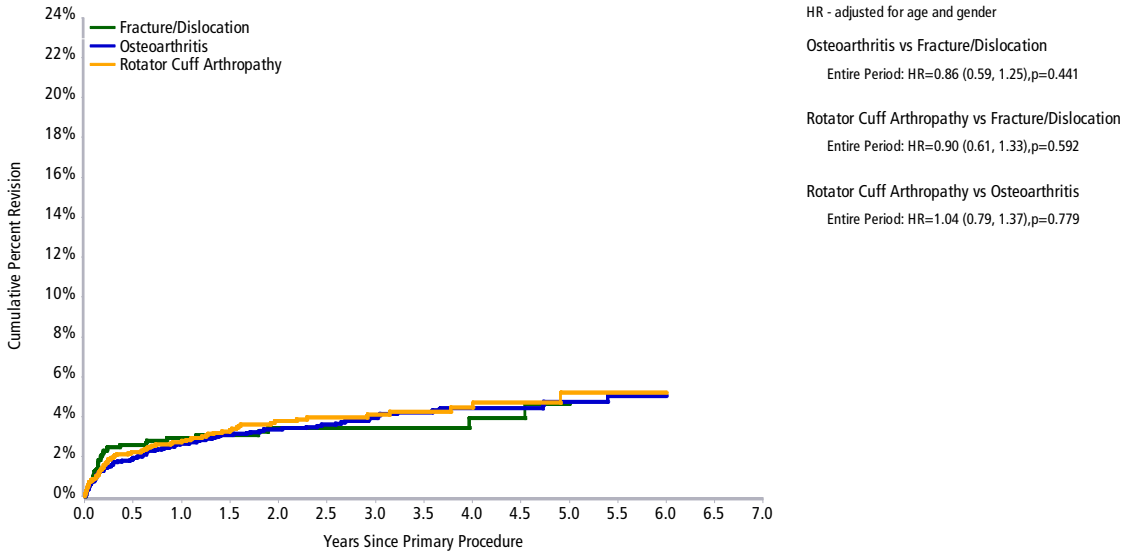
Note: Only Primary Diagnoses with over 100 procedures have been listed.

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture/Dislocation	2.9 (2.1, 4.1)	3.4 (2.4, 4.8)	3.4 (2.4, 4.8)	3.9 (2.7, 5.8)	4.6 (3.0, 7.2)		
Osteoarthritis	2.6 (2.1, 3.3)	3.4 (2.8, 4.1)	3.9 (3.2, 4.7)	4.4 (3.6, 5.3)	4.8 (3.9, 5.8)	5.0 (4.0, 6.3)	
Rheumatoid Arthritis	3.4 (1.5, 7.4)	4.1 (2.0, 8.5)	5.3 (2.6, 10.6)	7.2 (3.4, 14.6)			
Rotator Cuff Arthropathy	2.8 (2.2, 3.5)	3.8 (3.0, 4.7)	4.1 (3.3, 5.1)	4.5 (3.5, 5.6)	5.2 (3.9, 6.9)	5.2 (3.9, 6.9)	
Other (4)	4.2 (2.0, 8.7)	4.2 (2.0, 8.7)	5.9 (2.8, 12.4)				

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Fracture/Dislocation	1131	763	493	313	193	102	30	2
Osteoarthritis	3404	2576	1905	1324	875	459	162	22
Rotator Cuff Arthropathy	2500	1729	1161	687	401	173	68	19

Table ST47: Reason for Revision of Primary Total Reverse Shoulder Replacement

Reason for Revision	Number	Percent
Instability/Dislocation	113	43.5
Loosening/Lysis	51	19.6
Infection	34	13.1
Fracture	28	10.8
Pain	4	1.5
Implant Breakage Glenoid	4	1.5
Incorrect Sizing	4	1.5
Dissociation	4	1.5
Malposition	3	1.2
Implant Breakage Glenoid Insert	2	0.8
Rotator Cuff Insufficiency	2	0.8
Arthrofibrosis	2	0.8
Wear Glenoid Insert	1	0.4
Metal Related Pathology	1	0.4
Other	7	2.7
TOTAL	**260**	**100.0**

Table ST48: Type of Revision of Primary Total Reverse Shoulder Replacement

Type of Revision	Number	Percent
Cup/Head	77	29.6
Cup Only	59	22.7
Humeral Component	47	18.1
Head Only	40	15.4
Glenoid Component	16	6.2
Humeral/Glenoid	8	3.1
Removal of Prostheses	5	1.9
Cement Spacer	5	1.9
Reoperation	2	0.8
Head/Insert	1	0.4
TOTAL	260	100.0

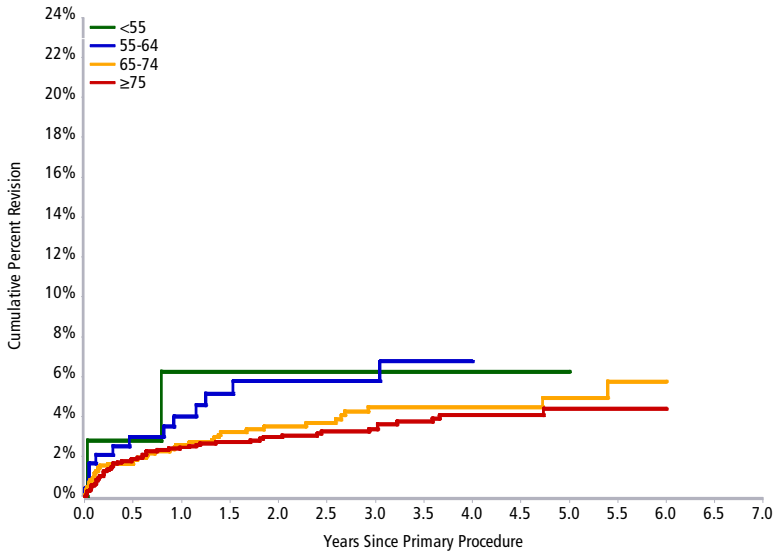
Table ST49: Revision Rates of Primary Total Reverse Shoulder Replacement by Age (Primary Diagnosis OA)

Age	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
<55	2	36	96	2.09 (0.25, 7.55)
55-64	13	243	633	2.05 (1.09, 3.51)
65-74	42	1122	2956	1.42 (1.02, 1.92)
≥75	63	2003	5245	1.20 (0.92, 1.54)
TOTAL	120	3404	8929	**1.34 (1.11, 1.61)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	6.3 (1.6, 23.0)	6.3 (1.6, 23.0)	6.3 (1.6, 23.0)	6.3 (1.6, 23.0)	6.3 (1.6, 23.0)		
55-64	4.0 (2.1, 7.6)	5.8 (3.3, 10.0)	5.8 (3.3, 10.0)	6.8 (3.9, 11.6)			
65-74	2.6 (1.8, 3.8)	3.5 (2.5, 4.9)	4.5 (3.2, 6.2)	4.5 (3.2, 6.2)	4.9 (3.5, 7.0)	5.8 (3.8, 8.6)	
≥75	2.5 (1.8, 3.3)	3.0 (2.3, 3.9)	3.4 (2.6, 4.4)	4.1 (3.1, 5.3)	4.4 (3.3, 5.8)	4.4 (3.3, 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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
<55	36	25	19	13	10	6	3	1
55-64	243	181	133	96	60	35	14	3
65-74	1122	843	614	433	306	163	62	6
≥75	2003	1527	1139	782	499	255	83	12

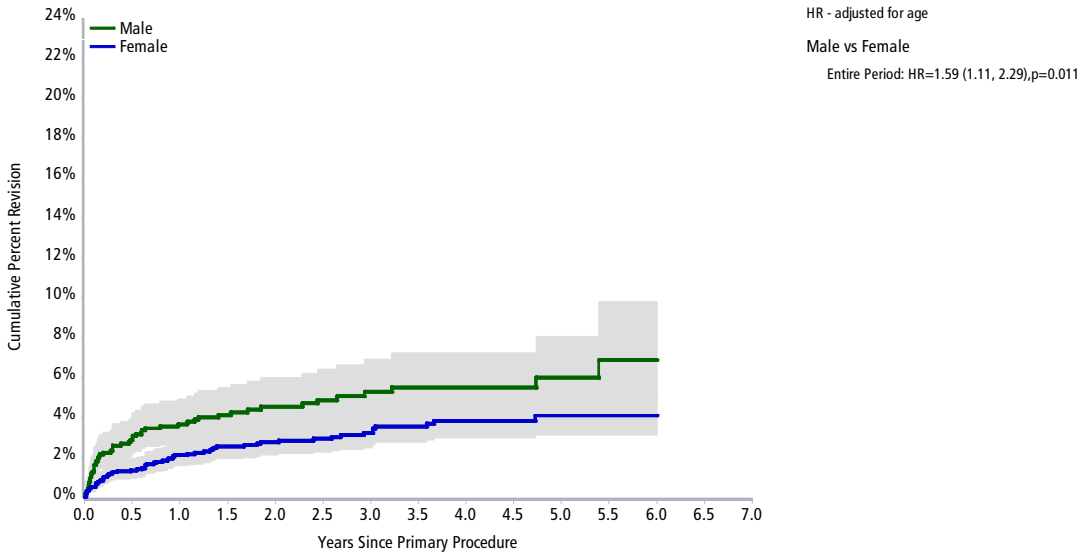
Table ST51: Revision Rates of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis OA)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	55	1187	3037	1.81 (1.36, 2.36)
Female	65	2217	5891	1.10 (0.85, 1.41)
TOTAL	**120**	**3404**	**8929**	**1.34 (1.11, 1.61)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	3.7 (2.7, 4.9)	4.5 (3.4, 6.0)	5.3 (4.0, 6.9)	5.5 (4.2, 7.2)	6.0 (4.4, 8.1)	6.9 (4.8, 9.8)	
Female	2.1 (1.6, 2.8)	2.8 (2.1, 3.6)	3.2 (2.5, 4.2)	3.8 (3.0, 5.0)	4.1 (3.1, 5.4)	4.1 (3.1, 5.4)	

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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	1187	886	634	437	297	154	61	6
Female	2217	1690	1271	887	578	305	101	16

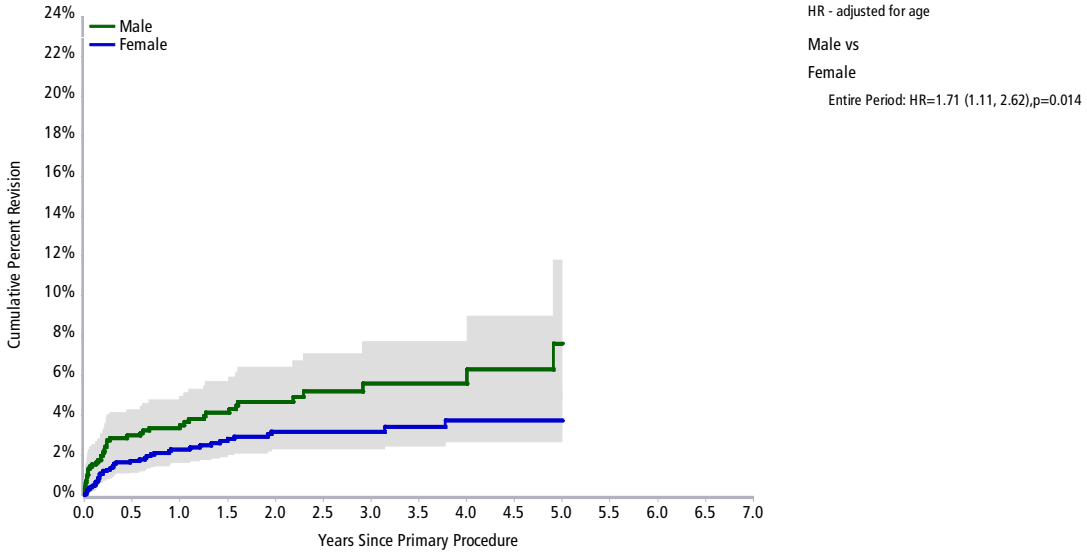
Table ST53: Revision Rates of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis Rotator Cuff Arthropathy)

Gender	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Male	44	973	1997	2.20 (1.60, 2.96)
Female	42	1527	3390	1.24 (0.89, 1.67)
TOTAL	**86**	**2500**	**5387**	**1.60 (1.28, 1.97)**

Table ST54: Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Gender (Primary Diagnosis Rotator Cuff Arthropathy)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	3.5 (2.5, 4.9)	4.7 (3.4, 6.4)	5.6 (4.1, 7.7)	5.6 (4.1, 7.7)	7.6 (4.9, 11.8)		
Female	2.3 (1.6, 3.3)	3.2 (2.3, 4.4)	3.2 (2.3, 4.4)	3.7 (2.7, 5.2)	3.7 (2.7, 5.2)		

Figure ST26: 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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Male	973	663	424	232	133	65	30	8
Female	1527	1066	737	455	268	108	38	11

Outcome by Prostheses Characteristic

Fixation

Fixation is not a risk factor for revision (Tables ST55 and ST56 and Figure ST27). This is also the case when the SMR total reverse shoulder is excluded from the analysis (Tables ST57 and ST58 and Figure ST28).

The outcomes of the most commonly used prostheses are listed in Tables ST59 and ST60.

.

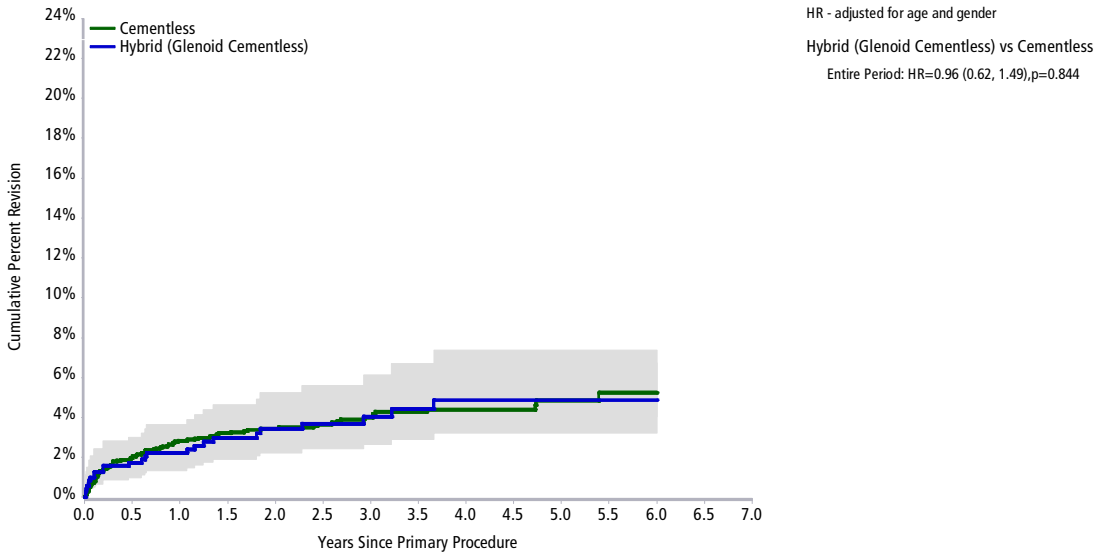
Table ST55: Revision Rates of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	0	52	185	0.00 (0.00, 1.99)
Cementless	95	2635	6856	1.39 (1.12, 1.69)
Hybrid (Glenoid Cemented)	0	9	19	0.00 (0.00, 19.28)
Hybrid (Glenoid Cementless)	25	708	1869	1.34 (0.87, 1.97)
TOTAL	**120**	**3404**	**8929**	**1.34 (1.11, 1.61)**

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

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 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)	
Cementless	2.8 (2.2, 3.6)	3.4 (2.8, 4.3)	4.0 (3.2, 4.9)	4.4 (3.6, 5.4)	4.8 (3.8, 6.1)	5.2 (4.0, 6.8)	
Hybrid (Glenoid Cemented)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)				
Hybrid (Glenoid Cementless)	2.2 (1.3, 3.7)	3.4 (2.2, 5.3)	4.0 (2.7, 6.1)	4.9 (3.2, 7.4)	4.9 (3.2, 7.4)	4.9 (3.2, 7.4)	

Figure ST27: 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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Cementless	2635	1974	1464	1018	670	347	113	21
Hybrid (Glenoid Cementless)	708	546	399	273	184	95	41	1

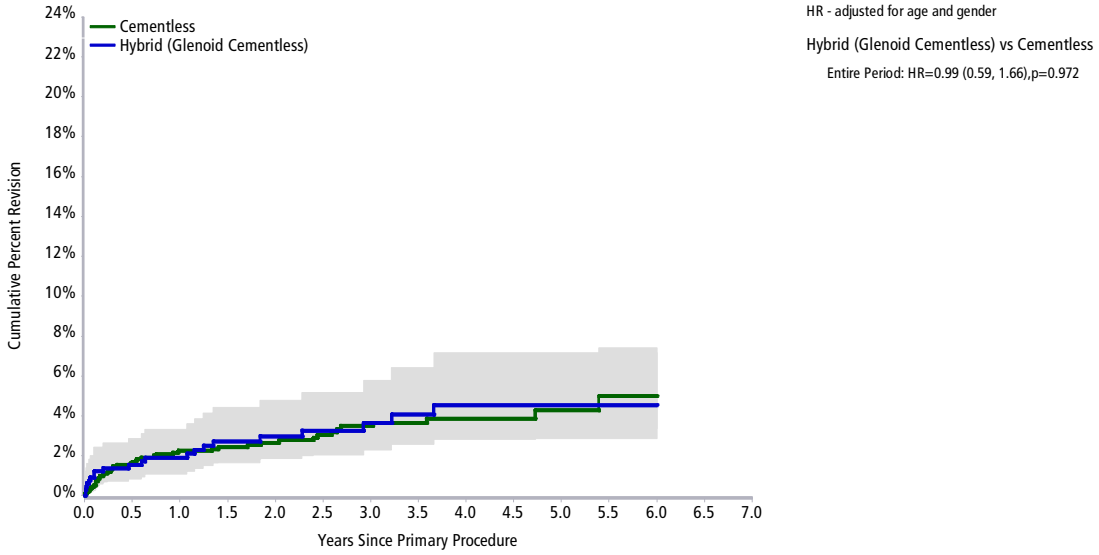
Table ST57: Revision Rates of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)

Fixation	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Cemented	0	52	185	0.00 (0.00, 1.99)
Cementless	47	1548	3901	1.20 (0.89, 1.60)
Hybrid (Glenoid Cemented)	0	7	13	0.00 (0.00, 28.81)
Hybrid (Glenoid Cementless)	21	658	1731	1.21 (0.75, 1.85)
TOTAL	**68**	**2265**	**5830**	**1.17 (0.91, 1.48)**

Table ST58: Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Fixation (Primary Diagnosis OA, excluding SMR)

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 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)	
Cementless	2.2 (1.6, 3.2)	2.7 (1.9, 3.7)	3.5 (2.6, 4.8)	3.9 (2.8, 5.3)	4.3 (3.1, 6.0)	5.0 (3.3, 7.4)	
Hybrid (Glenoid Cemented)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)					
Hybrid (Glenoid Cementless)	1.9 (1.1, 3.3)	3.0 (1.8, 4.8)	3.6 (2.3, 5.8)	4.5 (2.9, 7.2)	4.5 (2.9, 7.2)	4.5 (2.9, 7.2)	

Figure ST28: 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	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Cementless	1548	1142	822	571	363	189	62	14
Hybrid (Glenoid Cementless)	658	505	368	249	174	90	40	1

Table ST59: Revision Rates of Primary Total Reverse Shoulder Replacement by Humeral Stem and Glenoid

Humeral Stem	Glenoid Component	N Revised	N Total	Obs. Years	Revisions/100 Obs. Yrs (95% CI)
Aequalis	Aequalis	43	1195	2673	1.61 (1.16, 2.17)
Comprehensive	Comprehensive Reverse	3	70	82	3.64 (0.75, 10.65)
Delta CTA	Delta CTA	7	89	470	1.49 (0.60, 3.07)
Delta Xtend	Delta Xtend	67	2658	6194	1.08 (0.84, 1.37)
Mets	Mets	4	44	69	5.81 (1.58, 14.88)
Promos	Promos	2	56	215	0.93 (0.11, 3.36)
RSP	RSP	1	36	18	5.48 (0.14, 30.51)
SMR	SMR	117	2599	6482	1.80 (1.49, 2.16)
Trabecular Metal	Trabecular Metal	14	561	1281	1.09 (0.60, 1.83)
Vaios	Vaios	0	33	56	0.00 (0.00, 6.64)
Other (12)		2	75	84	2.38 (0.29, 8.61)
TOTAL		**260**	**7416**	**17624**	**1.48 (1.30, 1.67)**

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

Table ST60: Yearly Cumulative Percent Revision of Primary Total Reverse Shoulder Replacement by Humeral Stem and Glenoid

Humeral Stem	Glenoid Component	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Aequalis	Aequalis	2.4 (1.6, 3.5)	3.4 (2.4, 4.8)	4.4 (3.2, 6.2)	5.5 (3.9, 7.7)	6.2 (4.2, 8.9)	7.5 (4.7, 11.9)	
Comprehensive	Comprehensive Reverse	4.6 (1.5, 13.7)	4.6 (1.5, 13.7)					
Delta CTA	Delta CTA	5.7 (2.4, 13.1)	5.7 (2.4, 13.1)	6.9 (3.1, 14.6)	6.9 (3.1, 14.6)	6.9 (3.1, 14.6)	6.9 (3.1, 14.6)	9.2 (4.3, 19.2)
Delta Xtend	Delta Xtend	2.1 (1.6, 2.7)	2.6 (2.0, 3.3)	2.9 (2.2, 3.7)	3.3 (2.5, 4.3)	3.6 (2.7, 4.8)	3.6 (2.7, 4.8)	
Mets	Mets	10.0 (3.8, 24.5)	10.0 (3.8, 24.5)	10.0 (3.8, 24.5)				
Promos	Promos	0.0 (0.0, 0.0)	3.6 (0.9, 13.8)	3.6 (0.9, 13.8)	3.6 (0.9, 13.8)			
RSP	RSP	0.0 (0.0, 0.0)						
SMR	SMR	3.7 (3.0, 4.5)	4.7 (3.9, 5.6)	4.8 (4.0, 5.8)	5.3 (4.4, 6.5)	6.0 (4.9, 7.5)	6.5 (5.1, 8.3)	
Trabecular Metal	Trabecular Metal	1.9 (1.0, 3.6)	2.3 (1.2, 4.1)	3.7 (2.1, 6.5)	3.7 (2.1, 6.5)	3.7 (2.1, 6.5)		
Vaios	Vaios	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)					
Other (12)		3.9 (0.9, 15.7)	3.9 (0.9, 15.7)					

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 prostheses selection. For many prostheses the only source of outcomes data are registry reports.

It is evident from registry data that most prostheses have comparable 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.

Additionally, if a component represents more than 25% of the group, its revision rate is excluded from estimation of the group's overall rate.

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 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 being used and are identified for the first time.

The second group is prostheses that are being re-identified but are still used. This listing identifies that the prosthesis continues to have a higher than anticipated rate of revision but it also 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. 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 newly identified prostheses which are no longer used in Australia.

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, eight upper limb specialists attended the workshop under the leadership of Richard Page, together with the AOANJRR Director and two Deputy Directors.

The full analysis for all prostheses identified as having a higher than anticipated rate of revision in the 2014 Annual Report are available on the Registry website, https://aoanjrr.dmac.adelaide.edu.au/annual-reports-2014.

Primary Total Conventional Shoulder Replacement

There are two newly identified total conventional shoulder prostheses (Figure IP1).

The Comprehensive has been used in 58 procedures and has a two year cumulative percent revision of 10.1%. There have been five revisions, two of which are major. One involved revision of the humeral component only and the other revised both the humeral and glenoid components. The main reason for revision is rotator cuff insufficiency (40%).

The Vaios has been used in 35 procedures and has a two year cumulative percent revision of 17.6%. There have been seven revisions. Four of these are major revisions involving revision of the humeral component. The main reasons for revision are instability/dislocation, rotator cuff insufficiency and loosening/lysis.

In previous years the SMR has been listed as a single prostheses although the revision rates for the two main glenoid componets were presented seperatey. This year, the SMR L1 and SMR L2 are listed separately. The SMR L1 is still being used and the SMR L2 is no longer used.

Table IP1: Revision Rate of Individual Total Conventional Shoulder identified as having a Higher than Anticipated Revision Rate

Humeral/Glenoid	N Total	Obs. Years	Revisions/100 Obs. Yrs	Hazard Ratio, P Value
Newly Identified				
Comprehensive/Comprehensive	58	77	6.49	0 - 6Mth: HR=3.74 (1.19, 11.80),p=0.024
				6Mth+: HR=1.39 (0.35, 5.60),p=0.640
Vaios/Vaios	35	61	11.48	Entire Period: HR=4.12 (1.95, 8.71),p<0.001
Re-identified and still used				
SMR/SMR L1	1064	3244	2.68	Entire Period: HR=1.57 (1.24, 1.99),p<0.001
Identified and no longer used				
Univers 3D/Univers 3D	34	173	6.37	0 - 1.5Yr: HR=2.85 (1.06, 7.64),p=0.037
				1.5Yr - 4Yr: HR=2.33 (0.58, 9.41),p=0.236
				4Yr+: HR=15.52 (5.56, 43.32),p<0.001
SMR/SMR L2	855	2126	8.32	0 - 1.5Yr: HR=4.38 (3.46, 5.54),p<0.001
				1.5Yr - 2Yr: HR=6.92 (4.15, 11.53),p<0.001
				2Yr+: HR=10.18 (6.36, 16.29),p<0.001

Table IP2: Yearly Cumulative Percent Revision of Individual Total Conventional Shoulder identified as having a Higher than Anticipated Revision Rate

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Newly Identified							
Comprehensive/Comprehensive	10.1 (4.3, 22.6)	10.1 (4.3, 22.6)					
Vaios/Vaios	14.4 (6.2, 31.2)	17.6 (8.3, 35.0)					
Re-identified and still used							
SMR/SMR L1	5.5 (4.2, 7.2)	8.7 (7.0, 10.9)	9.6 (7.7, 11.9)	10.3 (8.3, 12.7)	11.0 (9.0, 13.6)	12.3 (9.8, 15.2)	
Identified and no longer used							
Univers 3D/Univers 3D	5.9 (1.5, 21.5)	14.7 (6.4, 31.8)	14.7 (6.4, 31.8)	17.9 (8.4, 35.5)	21.2 (10.7, 39.4)	28.5 (15.8, 47.9)	38.7 (20.3, 65.2)
SMR/SMR L2	9.4 (7.6, 11.6)	17.0 (14.6, 19.7)	22.0 (19.2, 25.2)				

Table IP3: Yearly Usage of Individual Total Conventional Shoulder identified as having a Higher than Anticipated Revision Rate

Year of Implant	≤2002	_2003	_2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Newly Identified												
Comprehensive/Comprehensive									5	12	22	19
Vaios/Vaios										16	17	2
Re-identified and still used												
SMR/SMR L1					16	119	237	247			157	288
Identified and no longer used												
Univers 3D/Univers 3D				1	6	16	11					
SMR/SMR L2								43	343	336	133	

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 IP1: Cumulative Percent Revision of Individual Total Conventional Shoulder Newly Identified

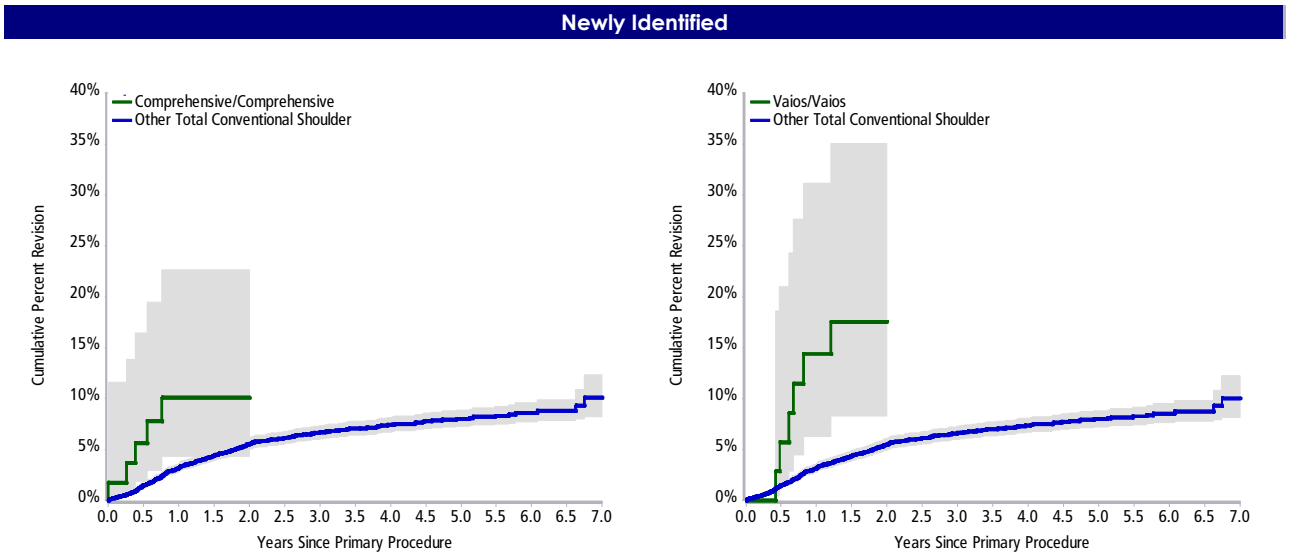
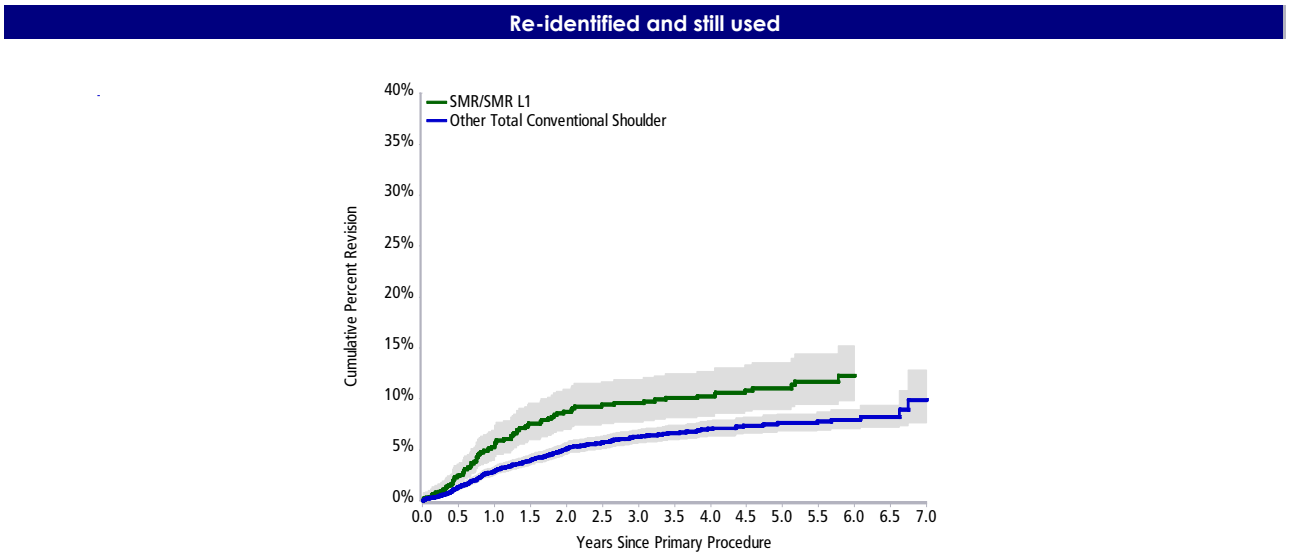


Figure IP2: Cumulative Percent Revision of Individual Total Conventional Shoulder Re-identified and still used



Primary Total Reverse Shoulder Replacement

There are no newly identified total reverse shoulder prostheses.

The Registry has previously identified the SMR total reverse shoulder. As is the situation with the SMR total conventional shoulder replacement there are a number of different glenoid prostheses and the outcome varies depending on which is used. The SMR L1 prosthesis has a higher than anticipated rate of revision (Figure IP4).

Table IP4: Revision Rate of Individual Total Reverse Shoulder 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	1459	3666	1.94	Entire Period: HR=1.56 (1.19, 2.06),p=0.001

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

Table IP5: Yearly Cumulative Percent Revision of Individual Total Reverse Shoulder identified as having a Higher than Anticipated Revision Rate

CPR	1 Yr	2 Yrs	3 Yrs	4 Yrs	5 Yrs	6 Yrs	7 Yrs
Re-identified and still used							
SMR/SMR L1	4.2 (3.2, 5.4)	5.3 (4.1, 6.8)	5.6 (4.4, 7.2)	6.1 (4.8, 7.8)	6.8 (5.3, 8.7)	7.3 (5.6, 9.5)	

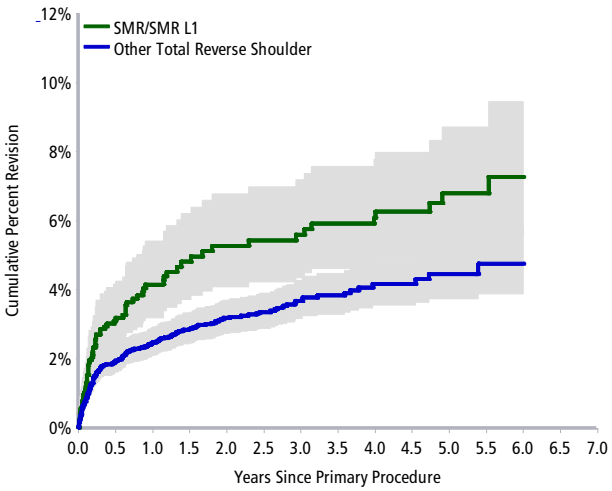
Table IP6: Yearly Usage of Individual Total Reverse Shoulder identified as having a Higher than Anticipated Revision Rate

Year of Implant	≤2002	_2003	_2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Re-identified and still used												
SMR/SMR L1				2	19	124	261	271			247	535

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 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 ($\chi 2$) 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 x [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 x 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 (31/12/2013) 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 1/1/2013 was revised on 1/7/2013. 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 1/1/2013 died without being revised on 1/4/2013. This procedure contributes 0.25 component years.
3. A primary procedure occurs on 1/1/2013 and has not been revised. This procedure contributes 1 component year (as observation time is censored at 31/12/2013).

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