Scottish Arthroplasty Project

Annual Report 2009

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1. Acknowledgments

The Scottish Arthroplasty Steering Committee would like to thank; Ivan Brenkel, for chairing the committee for the last three years; Colin Howie, for chairing the project for the previous three years and his continuing support to this project..

The Committee would like to acknowledge the helpful contributions of Tim Norwood, Santiago Nieva and Euan Paterson who work as analysts on the project. We would like to thank Dr Jamie Pearson who is the Scottish Joint Registry coordinator, Dr Penny Bridger Consultant in Public Health and Dr Margaret Macleod Quality Improvement Programme Manager. We would also like to thank Andrew Kinninmonth and Paddy Ashcroft who were the Orthopaedic Surgeons on this committee. Dr David Semple who is responsible for the aneasthetic input. In addition we would like to thank Ms. Miriam Watts who represents the independent sector, Hazel Bruce and Katy Green for representing the patients. We also thank Dominic Meek, an Orthopaedic Surgeon, for his contributions to the Report.

Finally we would like to thank Jennifer Boyd who has coordinated this project from 2006.She has done an excellent job over the years and will be missed when she leaves us temporally. We wish her all the best with her maternity leave and hope to see her back with the project soon.

2. Key Points

• There were 6,312 hip replacements and 6,160 knee replacements recorded in 2007/08. Unlike previous Reports, we include surface hip replacements and hybrid hip replacements, which explains why the numbers of hip replacement will be slightly different to previous years. Hip revisions have fallen slightly (875) but knee revisions continue to rise (412). Ankle and toe replacements have significantly increased over the last two years (48 and 55, respectively). See the National Trends section on page 8.

• The length of stay for hip replacements continues to fall year on year. It has decreased from an average of 12.7 days in 1996/97 to 7.5 days in 2007/08. The length of stay for knee replacements has decreased from 13.2 days in 1996/97 to 7.2 days in 2007/08. More patients are admitted on the day of surgery. See the Length of stay section on page 14.

• This year length of stay by age group has been analysed. Patients undergoing hip and knee replacements under 60 have half the length of stay compared to patients over 80. See Figure 17 and Figure 18 on page 16. We also looked at patient numbers and median age split by sex over 10 years. See Figure 19 to Figure 22 from page 18.

• Surgeons and NHS Boards are fully engaged in the Clinical Governance process. The improvement in the content and quality of the responses of the outliers suggests greater ownership and commitment to the aims of the project. See the Clinical Governance Policy and Results section on page 22.

• Death, dislocation and deep vein thrombosis (DVT/PE) following joint replacement have all reduced, in some cases markedly, over the past four years. The complication rate for an infection following a knee replacement has decreased over the past year, but has slightly increased for hip replacements. The Committee will be monitoring this as part of the Clinical Governance process. (See Figure 23 on page 27).

• The definition of hip dislocations was redefined based on feedback from consultants and advice from coding experts. Two OPCS codes can be used to identify a hip dislocation. Some coders were using ‘Attention To Total Prosthetic Replacement Of Hip Joint, N.E.C.' (W394). Whilst other codes were using ‘Attention To Total Prosthetic Replacement Of Hip Joint, N.E.C.' (W394) paired with ‘Correction of displacement of prosthesis, not elsewhere classified’ (Y033). We have written to all coders to draw their attention to this issue and ensure parity in the codes used across Scotland. This year we have included both classifications of hip dislocation.

• Individual Anaesthetic departments are participating in the audit at a hospital level. For this Report, we have now included Hip and Knee Revisions in addition to Arthroplasties. Complications such as stroke, acute myocardial infarction, and acute renal failure have been included in the Report. This year, all the data have been standardised for age, sex, admission from home or other place of residence (e.g. nursing home), rheumatoid arthritis, and deprivation. See the Anaesthetic Complications section on page 40.

• This year we have looked at the cross border flows of patients who undergo hip and knee arthroplasty or revision. These tables show the number of local residents who have either: received treatment in their own NHS Board; have been exported to a different NHS Board for treatment and patients who have been imported to that NHS Board for their operation. See the Cross Border Flow of Hip and Knee Arthroplasty and Revision Surgery within Scotland section on page 46.

• Finally in the 2007 Annual Report, we looked at the knee arthroscopy. We found a wide variation in the rates across Scotland. In particular we found that NHS Boards that had a high rate of arthroscopy in patients over 60 also had a high rate of these patients going on to have a knee replacement within two years. The rate of arthroscopy was re-analysed this year. There has been a slight decrease in the rate of arthroscopy in some NHS Boards, but there remains a wide variation throughout Scotland. See the Knee Arthroscopies section on page 56.

3. Introduction

For 2009, we have again produced an abridged report for paper release, the full report (including detailed named NHS Board data) and all previous reports are available on the SAP website at www.arthro.scot.nhs.uk.

We hope that the public will continue to recognise and support the considerable commitment made by the Scottish Orthopaedic community to the governance process resulting in demonstrable improvements. Patients are encouraged to discuss their forthcoming joint replacement and possible outcomes with their consultant. At that consultation, the patient can be assured that the surgeon is aware of his own results and that the NHS Board results are freely available in this report.

This SAP report, includes:

• National trends in joint replacement

• Length of stay for hip and knee replacements

• Patient characteristics for hip and knee replacements

• Clinical governance

• Complications for hip and knee replacements

• Anesthetic complications

As before, we include analyses that are new this year. These areas are:

• Cross Border Flow of Hip and Knee Arthroplasty and Revision Surgery

Finally we have also revisited knee arthroscopy which we looked at in 2007.

Surgeons and NHS Boards are complying with the arthroplasty governance process. Perhaps most encouraging is that we can continue to detect an overall improvement in some negative outcomes over time (infection, death, DVT/PE and dislocation).

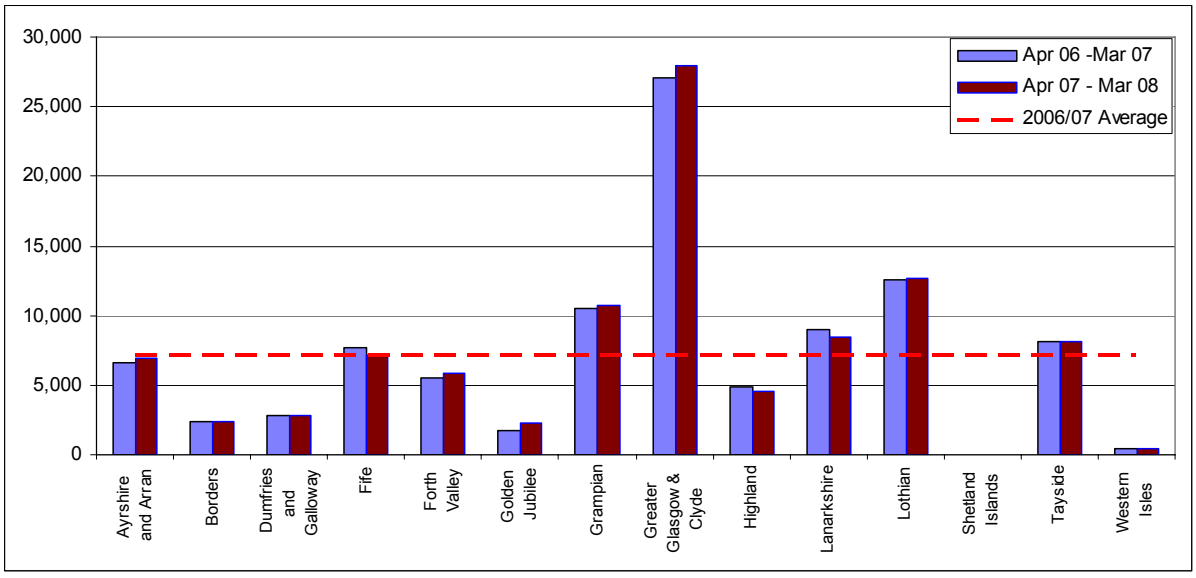
4. Data Completeness

Hospitals send SMR01 records (Scottish Morbidity Records), used by the Scottish Arthroplasty Project, to the Information Services Division (ISD) retrospectively. SMR01 records are created every time an individual is treated in hospital as an inpatient or daycase. The national standard states that these records should be sent to ISD within six weeks of a patient's discharge from hospital. Details about how data completeness is determined can be found in section 4.2 of the 2004 Annual Report and on the 'Managing Data Quality' section on the ISD Website (www.isdscotland.org/isd/831.html).

The latest data in this report are for patients treated in hospital between 1st April 2007 and 31st March 2008. ISD conducts a routine 2% case note review to assess the quality of coding. We are confident that the record sets that are used are sufficiently complete and accurate to make statistically valid conclusions.

Figure 1 compares the number of Orthopaedic and Trauma discharges for each NHS Board in Scotland for financial years 2006/2007 and 2007/2008. Please note that this chart does not exclusively show data for Arthroplasty surgery.

Figure 1: Number of discharges for financial years 2006/2007 and 2007/2008, based on SMR01 records received by 30th of April 2009.



5. National Trends

Figure 2 to Figure 5 represent the numbers of combined elective and emergency joint replacement operations (both primary and revision for hip and knee) recorded as performed in NHS Scotland in each of the last 16 years (1992 to 2008). The vast majority of operations were performed as an elective procedure; around 92.3% of primary hip replacements, 99% of primary knee replacements, 76.8% of revision hip replacements and 90.7% of revision knee replacements. All numbers are displayed by financial year ending 31st March.

The number of primary hip and knee replacements has been increasing steadily since 1992, with a marked rise from 2002 to 2007. In 2007/08 there were 6312 primary hip replacements and 6160 primary knee replacements. There has been a slight decrease in the past year in the number of hip and knee operations. Joint replacements are also performed in the independent sector, with some being paid for by the NHS as part of the waiting list initiative, but complete data relating to these is not available centrally. Please note that primary hip replacements figures now include hybrid and re-surfacing operations of the hip.

Figure 2: Primary Hip Replacements by year ending March

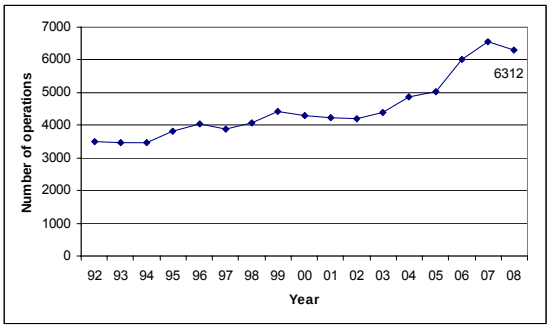


Figure 3: Primary Knee Replacements by year ending March

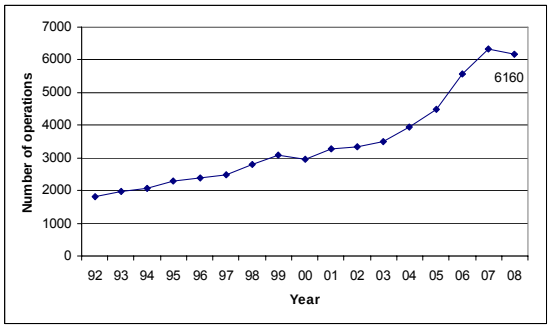


Figure 4: Revision Hip Replacements by year ending March

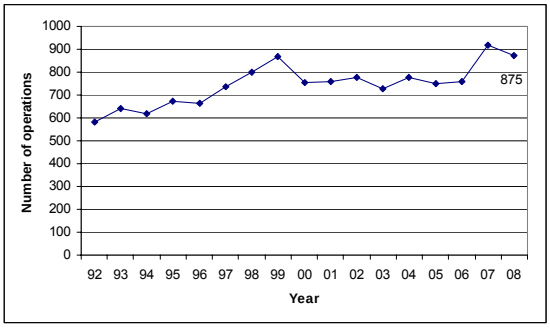
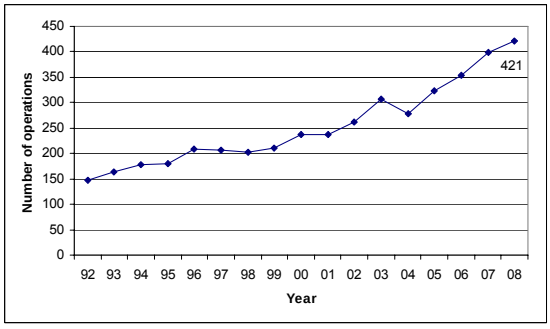


Figure 5: Revision Knee Replacements by year ending March



Further arthroplasty activity trend charts can be found in the Operations Performed by Surgeons Carrying Out Small Volumes of Procedures section on page 10.

Table 1 shows the ratios of primary operations to revision operations for hip and knee in Scotland and compared to those reported in other countries that perform arthroplasty audits. The figures are based on crude rates and show the revision rate for primary hip operations requiring some form of revision. The highest rate is in Australia (14.97%) with the lowest in Sweden (8.01%). Knee revision rates are lowest in England (4.69%) and highest in Australia (9.52%). The lower rate of revision for knee replacements compared with hip replacements reflects the relatively small number of knee replacements carried out 10-20 years ago.

Please note that data may not be comparable due to different coding and data collection methods being employed in different countries.

Table 1: International Comparison of primary to revision (for all causes) operation ratios

Hips	Scotland Apr 07 - Mar 08	Australia[1] July 06 - Jun 07	Norway[2] Jan 07 - Dec 07	USA[3] Jan 06 - Dec 06	Sweden[4] Jan 07 - Dec 07	Canada[6] April 05 - Mar 06	England[7] April 07 - Mar 08
Primary Operations	6,312	21,791	6,643	231,000	14,105	11,430	62,253
Revisions	875	3,837	1,043	38,000	1,228	1,521	5,757
Primary + Revision	7,187	25,628	7,686	269,000	15,333	12,951	68,010
Crude Revision Rate %	12.17%	14.97%	13.57%	14.13%	8.01%	11.74%	8.46%

Knees	Scotland Apr 07 - Mar 08	Australia[1] July 06 - Jun 07	Norway[2] Jan 07 - Dec 07	USA[3] Jan 06 - Dec 06	Sweden[5] Jan 07 - Dec 07	Canada[6] April 05 - Mar 06	England[7] April 07 - Mar 08
Primary Operation	6,160	27,606	3,556	542,000	10,380	17,082	68,654
Revision	421	2,903	299	39,000	617	973	3,377
Primary + Revision	6,581	30,509	3,855	581,000	10,997	18,055	72,031
Crude Revision Rate %	6.40%	9.52%	7.76%	6.71%	5.61%	5.39%	4.69%

1 AOA National Joint Replacement Registry
2 Norwegian Arthroplasty Register
3 American Academy of Orthopaedic Surgeons
4 Swedish Hip Arthroplasty Register
5 Swedish Knee Arthroplasty Register
6 Canadian Joint Replacement Registry
7 English National Joint Registry

6. Additional National Trends in Numbers of Operations

1.1. Number of Arthroplasty Procedures Performed per Surgeon

Each consultant and hospital has a unique work pattern and arthroplasty represents only a small part of that workload. These figures should therefore not be seen as total workload figures. It should also be noted that consultants commencing or retiring from their post during the year may well appear to be performing low volumes of procedures if they were not working for the whole year.

A total number of 203 consultant surgeons are recorded as having performed primary hip replacements in 2008 in NHS Scotland. There were 87 consultant surgeons who performed less than 21 primary hip replacements. A total number of 180 consultant surgeons are recorded as having performed primary knee replacements in 2008 in NHS Scotland. There were 66 consultant surgeons who performed less than 21 primary knee replacements.

Previous reports (Scottish Arthroplasty Project Annual Report 2003) have highlighted that performing low volumes of procedures can result in higher rates of deep vein thrombosis (DVT), infected prosthesis and dislocation of prosthesis, but not in higher rates of revision surgery.

In an attempt to make the data more understandable (and to observe change) annualised figures for the percentage of arthroplasty surgery carried out by surgeons performing less than a specific number of procedures have been reported in the Operations Performed by Surgeons Carrying Out Small Volumes of Procedures section on page 10. This provides another perspective on surgery being carried out by surgeons performing low numbers. However, both this analysis and the charts following are confounded by the turnover of consultant surgeons and locums noted above.

1.2. Operations Performed by Surgeons Carrying Out Small Volumes of Procedures

Figure 6 and Figure 7 represent the number of primary and revision operations carried out by a surgeon doing less than a specified number of operations per year. This year the limits are 20 and under for primary hip and knee replacements, 10 and under for revision hip

replacements and five and under for revision knee replacements. All numbers are displayed by financial year ending 31st March.

Figure 6: % of hip replacements by surgeons carrying out small volumes of procedures per year

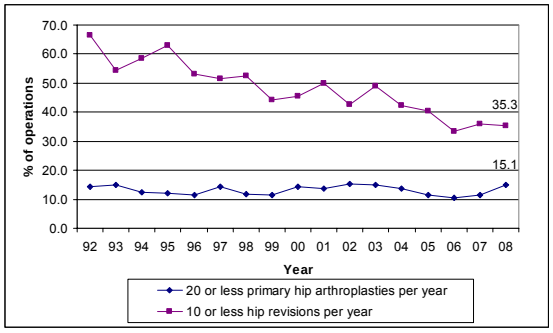
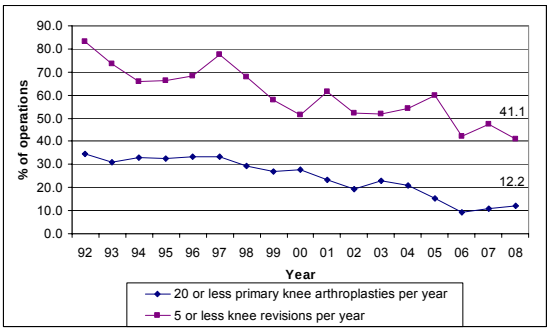


Figure 7: % of knee replacements by surgeons carrying out small volumes of procedures per year



1.3. Additional National Trends in Numbers of Operations

Figure 8 to Figure 14 show the numbers of finger, wrist, thumb, toe and ankle arthroplasties (primary and revision). All numbers are displayed by financial year ending 31st March. The number of elective and emergency joint replacement operations (for both primary and revision for hip and knee) can be seen on page 8.

From 1991/92 to 1997/98, the number of ankle arthroplasties remained relatively constant with only one or two occurring. Since 1997/98, however, there has been a steady increase in the number of ankle arthroplasties carried out. The number of procedures has risen from one in 1997/98 to 48 in 2007/08 (see Figure 8). The number of toe arthroplasties has slowly decreased over time from 46 procedures in 1991/92 to 18 procedures in 2004/05 (see Figure 10). However the number of procedure has shown a steady increase since 2004/05 from 18 to 55 procedures in 2007/08.

The number of thumb arthroplasties carried out each year increased from 6 to 70 operations between 1991/92 and 2007/08 (see Figure 12). The number of primary finger arthroplasties has remained relatively stable at between 40 and 60 procedures from 1991/92 to 2006/07 (see Figure 13). However there has been a slight reduction in 2007/08 to 36 arthroplasties. There has been an increase in the number of primary wrist arthroplasties performed from ten procedures in 1991/92 to 27 in 1995/96. Between 1999/00 and 2003/04, the volume of wrist arthroplasties has remained static at around 10 procedures per year. However, there has been an increase from 18 in 2006/07 to 25 in 2007/08 (see Figure 14).

Figure 8: Primary Ankle Arthroplasties by year ending March

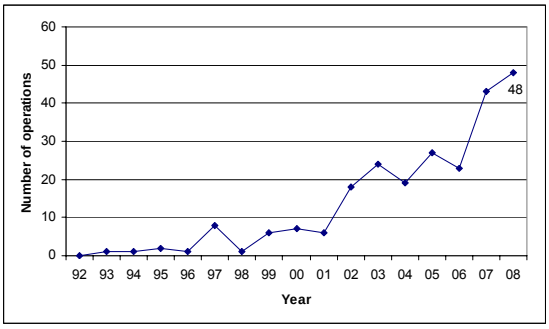


Figure 9: Revision Ankle Arthroplasties by year ending March

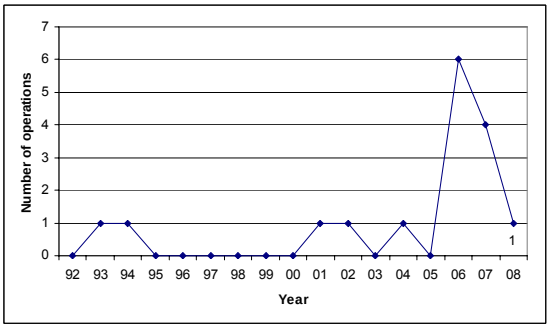


Table 2: Ankle arthroplasty consultant numbers and procedures performed per year

	YEAR							
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Number of Consultants	4	6	7	7	8	8	9	7
Number of Operations	6	18	24	19	27	23	43	48

Figure 10: Primary Toe Arthroplasties by year ending March

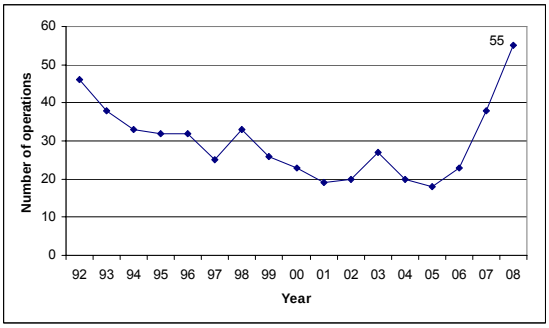


Figure 11: Revision Toe Arthroplasties by year ending March

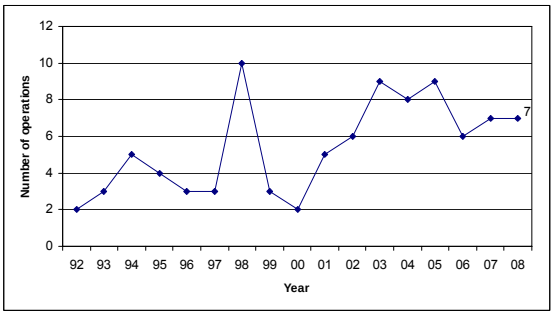


Table 3: Toe arthroplasty consultant numbers and procedures performed per year

	YEAR							
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Number of Consultants	9	10	13	10	10	12	17	21
Number of Operations	19	20	26	20	18	23	38	55

Table 4: Thumb arthroplasty consultant numbers and procedures performed per year

	YEAR							
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Number of Consultants	8	4	6	7	9	9	14	16
Number of Operations	26	28	28	15	24	25	52	70

Figure 12: Primary Thumb Arthroplasties by year ending March

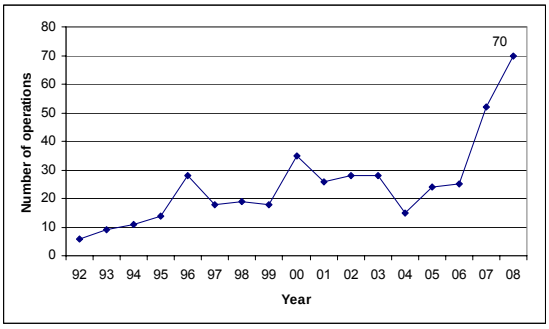


Figure 13: Primary Finger Arthroplasties by year ending March

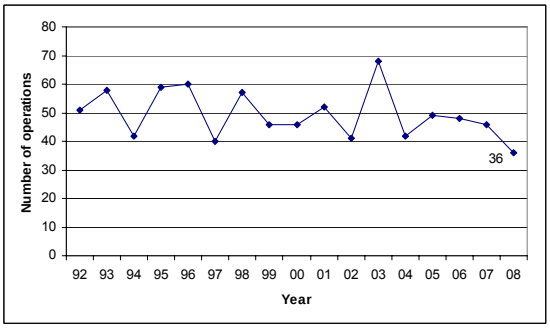
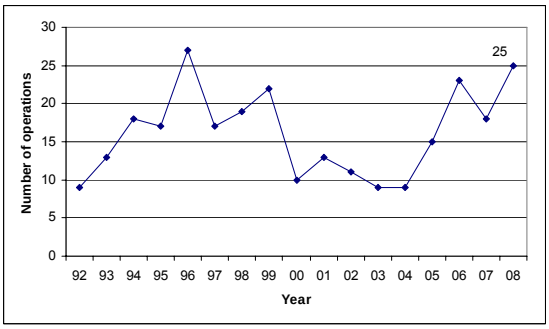


Figure 14: Primary Wrist Arthroplasties by year ending March



7. Length of stay

Table 5 and Table 6 show the mean length of stay per hospital stay in each NHS Board for between 1997/98 and 2007/08 for elective primary hip and elective primary knee replacements.

On the 1st April 2006/07, NHS Argyll & Clyde was dissolved and split between NHS Greater Glasgow and NHS Highland. The tables throughout this chapter have been adapted to accommodate this change and therefore no data is shown for Argyll & Clyde from 2006/07 onwards. North Glasgow, South Glasgow, and Clyde are part of Greater Glasgow & Clyde NHS Board.

Over the course of the last 11 years, there has generally been a steady drop in the mean length of stay for patients having hip replacements (see Table 5). The largest decrease is by 5.9 days in NHS Tayside. However, there has been a slight increase in the mean length of stay from 11.8 days in 1997/98 to 13.8 days in 2007/08 for the Western Isles NHS Board. It should be noted that this was the only NHS Board where a rise was seen and could be insignificant due to the relatively small number of hip replacements carried out there.

With knee replacements there was a general downward trend in mean length of stay over the 11 years across the NHS Boards (see Table 6). The greatest drop on the mean was seen in NHS Highland, where the mean decreased from 13.9 days to 7.6 days.

Two NHS Boards, Lothian and Forth Valley, have significantly more patients admitted on the day of surgery compared to last year. Some NHS Boards such as Borders and Dumfries and Galloway, and Golden Jubilee National Hospital and North Glasgow have less than 5% of their patients admitted on the day of surgery. There is no clear correlation between day of admission and length of stay. Lanarkshire had one of the highest number of patients admitted on the day of surgery and also has one of the highest mean length of stay. Golden Jubilee had very few patients admitted on day of surgery yet had the lowest mean length of stay in Scotland.

Table 5: Mean Length of Stay per Continuous Inpatient Stay for Hip Replacements

	Year										
	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08
Scotland	12.2	11.9	11.7	10.3	10.3	10.2	9.7	9.2	8.7	8.0	7.5
Ayrshire and Arran	12.6	13.0	12.2	10.7	10.6	10.6	10.1	9.9	9.8	9.4	9.0
Borders	11.7	11.3	10.2	10.4	9.9	10.2	9.4	9.4	10.0	10.4	8.7
Argyll & Clyde	12.8	13.5	12.6	11.8	10.5	10.0	8.9	8.8	8.9	-	-
Dumfries and Galloway	11.8	12.6	12.3	11.0	11.6	11.0	11.4	11.1	10.7	10.9	10.5
Fife	10.3	10.6	10.2	8.9	9.4	9.6	9.6	9.6	9.4	8.4	6.6
Forth Valley	12.2	13.7	14.7	12.3	12.0	12.3	11.8	10.7	9.4	9.8	8.3
Golden Jubilee	-	-	-	-	-	9.8	9.0	7.6	7.6	7.0	6.0
Grampian	12.7	13.0	14.1	11.8	11.5	11.4	10.1	9.9	9.1	7.9	8.5
Greater Glasgow and Clyde											
- Clyde	-	-	-	-	-	-	-	-	-	8.9	7.2
- North Glasgow	11.9	10.9	9.4	9.7	10.0	9.2	9.8	9.0	7.9	7.0	7.0
- South Glasgow	12.3	11.2	11.3	10.0	11.4	12.3	10.2	9.5	8.7	7.6	7.9
Highland	12.8	13.0	10.4	9.1	8.6	9.6	8.8	8.9	7.7	7.2	7.3
Lanarkshire	14.4	13.1	13.0	12.0	10.7	11.3	10.7	11.0	10.7	9.4	9.6
Lothian	10.4	8.9	9.2	8.4	7.9	8.4	8.1	8.0	7.4	7.0	6.5
Tayside	13.3	12.5	12.7	10.6	11.3	9.9	9.5	8.6	8.3	8.8	7.4
Western Isles	11.8	11.2	13.5	14.9	13.8	14.2	15.2	14.9	19.1	13.2	13.8

Table 6 : Mean Length of Stay per Continuous Inpatient Stay for Knee Replacements

	Year										
	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08
Scotland	12.2	11.8	11.3	10.5	10.0	9.7	9.2	8.8	8.1	7.6	7.2
Ayrshire and Arran	12.6	12.2	11.6	11.2	10.8	9.7	9.5	10.1	9.5	9.0	8.7
Borders	14.8	13.8	11.7	11.5	10.4	9.8	9.5	9.4	10.7	9.8	8.6
Argyll & Clyde	12.8	12.3	11.6	10.3	9.9	9.7	8.2	8.9	8.6	-	-
Dumfries and Galloway	13.0	13.1	11.5	12.2	11.0	11.2	12.1	13.2	11.7	10.2	10.3
Fife	10.2	10.0	9.4	9.7	8.5	9.1	9.9	9.7	8.6	7.6	6.9
Forth Valley	12.3	13.3	13.6	12.6	11.4	11.2	10.6	10.0	9.2	7.8	8.2
Golden Jubilee	-	-	-	-	-	9.8	8.7	8.1	7.8	7.5	6.0
Grampian	13.7	13.6	13.3	12.0	11.1	10.8	10.4	9.8	8.6	7.4	8.3
Greater Glasgow and Clyde											
- Clyde	-	-	-	-	-	-	-	-	-	8.3	7.3
- North Glasgow	10.8	10.7	10.2	9.8	10.0	9.4	8.8	8.4	7.9	7.0	6.5
- South Glasgow	12.1	11.6	11.0	10.7	12.0	11.6	9.8	9.4	8.1	7.9	7.3
Highland	13.9	13.7	10.5	9.4	8.7	9.7	8.6	7.6	7.6	7.2	7.6
Lanarkshire	14.7	13.9	13.8	11.4	10.6	9.8	9.4	9.4	8.9	8.4	8.9
Lothian	10.2	9.1	9.3	8.5	7.8	7.8	7.0	7.2	6.6	6.5	6.1
Tayside	12.9	12.4	11.8	11.0	10.4	9.6	9.1	8.1	7.6	7.7	7.2
Western Isles	17.6	14.4	9.7	11.5	9.6	13.5	13.1	15.0	14.9	12.1	12.1

Figure 15 and Figure 16 show the average length of stay for elective primary hip and elective primary knee replacements respectively in each of the last 11 years (1997/98 to 2007/08).

Figure 15: Average Length of Stay per Continuous Inpatient Stay for Hip Replacements by year ending March

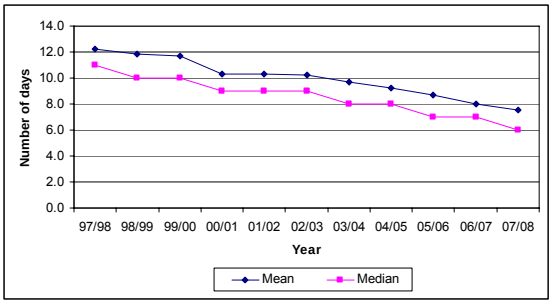


Figure 16: Average Length of Stay per Continuous Inpatient Stay for Knee Replacements by year ending March

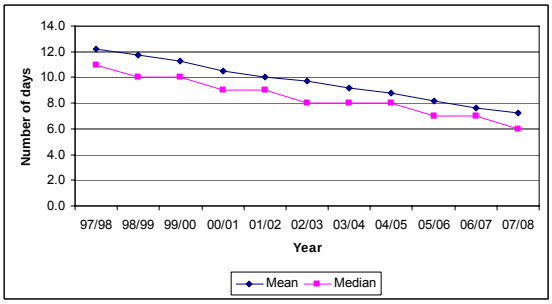


Figure 17 and Figure 18 show the average length of stay by age group. Average length of stay for hip and knee replacements both show a reduction over time in the average length of

stay for all ages, with primary knee patients having shorter stays within hospital than primary hip patients.

Figure 17: Mean Length of stay in hospital for hip replacements by age

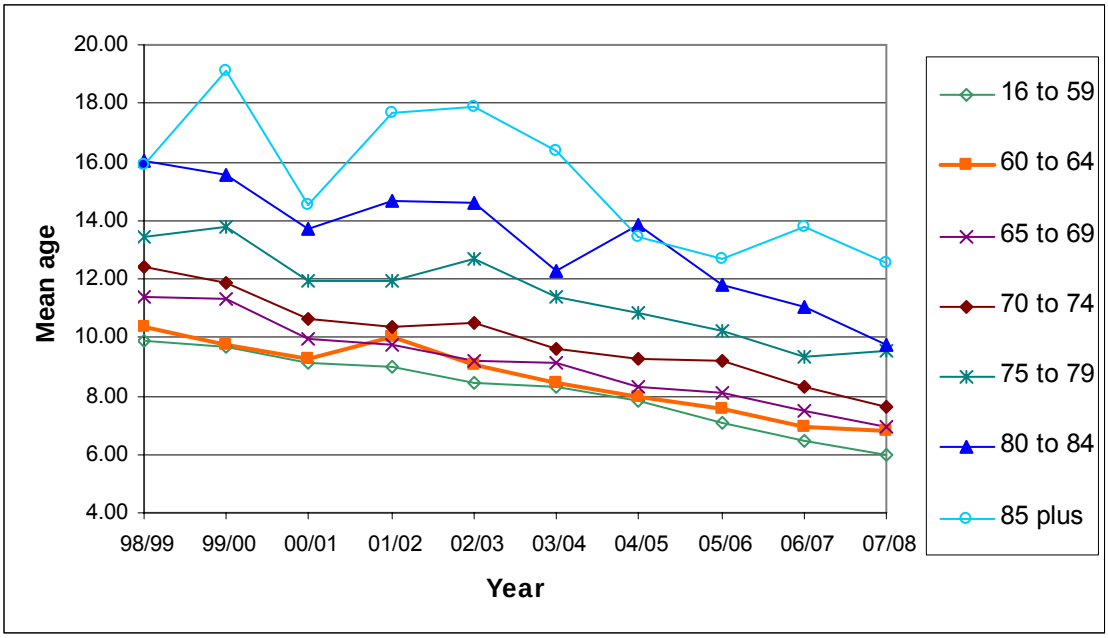
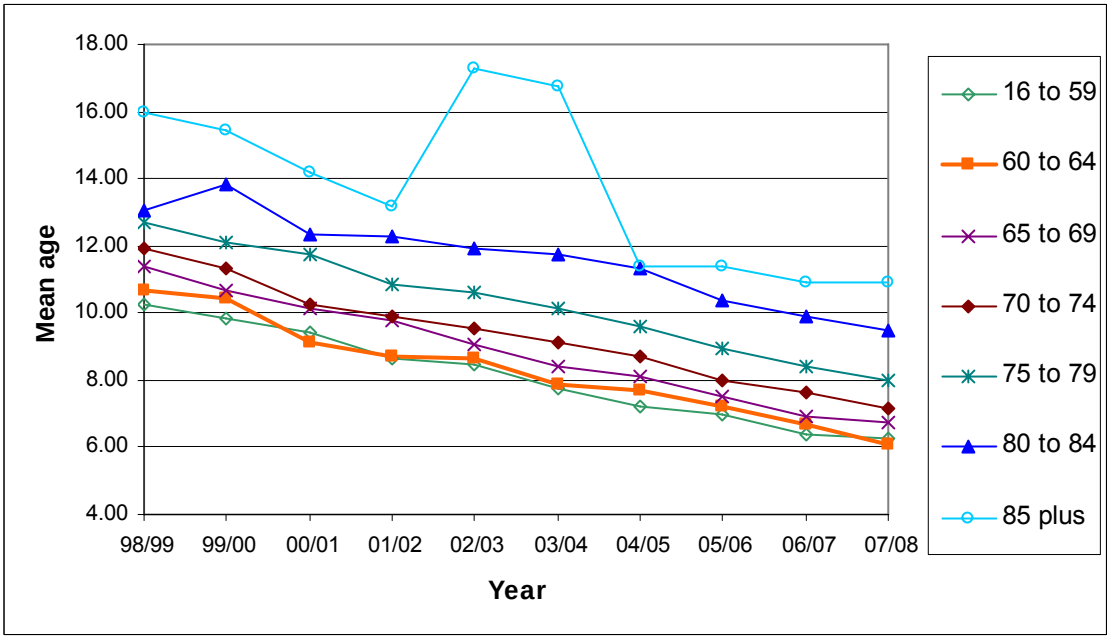


Figure 18: Mean Length of stay in hospital for knee replacements by age



8. Patient Characteristics

This section gives more detailed information on patients who underwent either a total hip replacement operation or total knee replacement operation in 2007/08. The information in this section is contained in a number of tables broken down as follows:

- Sex and average age
- Carstairs deprivation quintile
- Laterality of procedure
- Number of operations by age and NHS Board
- Principal diagnosis of patient at time of operation

As of 1st April 2006, NHS Argyll & Clyde was dissolved and split between NHS Greater Glasgow and NHS Highland. Table 10 and Table 14 have been adapted to accommodate this change and therefore no value is shown for Argyll & Clyde from 2006/07 onwards. North Glasgow, South Glasgow, and Clyde are part of Greater Glasgow & Clyde NHS Board.

Table 7 to Table 10, and Figure 19 to Figure 20 shows information for patients who have undergone a primary hip replacement. Table 11 to Table 14 and Figure 21 to Figure 22 shows information for primary knee replacement patients. Please note that complete for joint replacements performed in the independent hospitals is not available centrally and so is not shown.

1.4. Hip Replacements

Table 7: Number of patients who have undergone a hip replacement in 2007/08 split by sex

Sex	Number of Patients	Median Age
Male	2495	67
Female	3783	70
Total	6278	69

Figure 19: Patient numbers and median age split by sex over 10 years

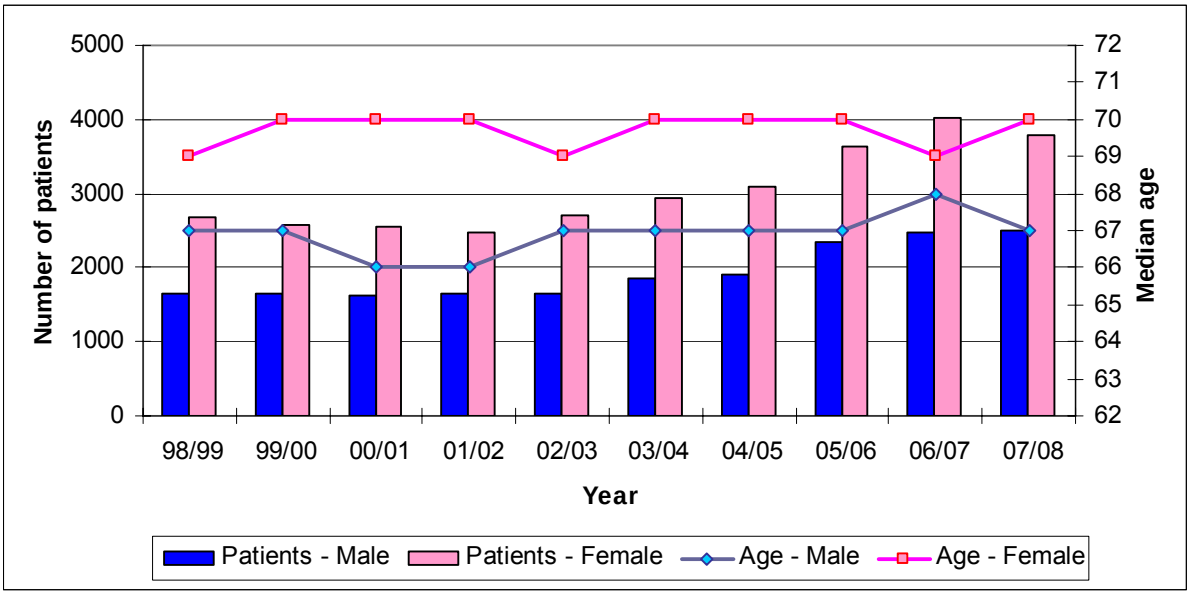


Table 8: Deprivation category of patients by age

	Number of patients by age range							
Deprivation category	16 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 to 84	85 plus	Total
1 Most Affluent	265	193	238	251	222	131	76	1376
2	265	218	228	278	221	131	63	1404
3	298	188	223	281	200	109	58	1357
4	266	180	214	202	181	95	41	1179
5 Least Affluent	256	118	149	171	142	67	37	940
Not known	3	6	4	2	3	2	2	22
Total	1353	903	1056	1185	969	535	277	6278

The smaller number of treated patients in the Least Affluent category may represent the reduced life expectancy in these deprivation categories such that they may die before they require a joint replacement. Previous work in the Scottish Arthroplasty Annual report 2008 suggests that these deprivation categories are being treated.

Table 9: Laterality of hip replacement

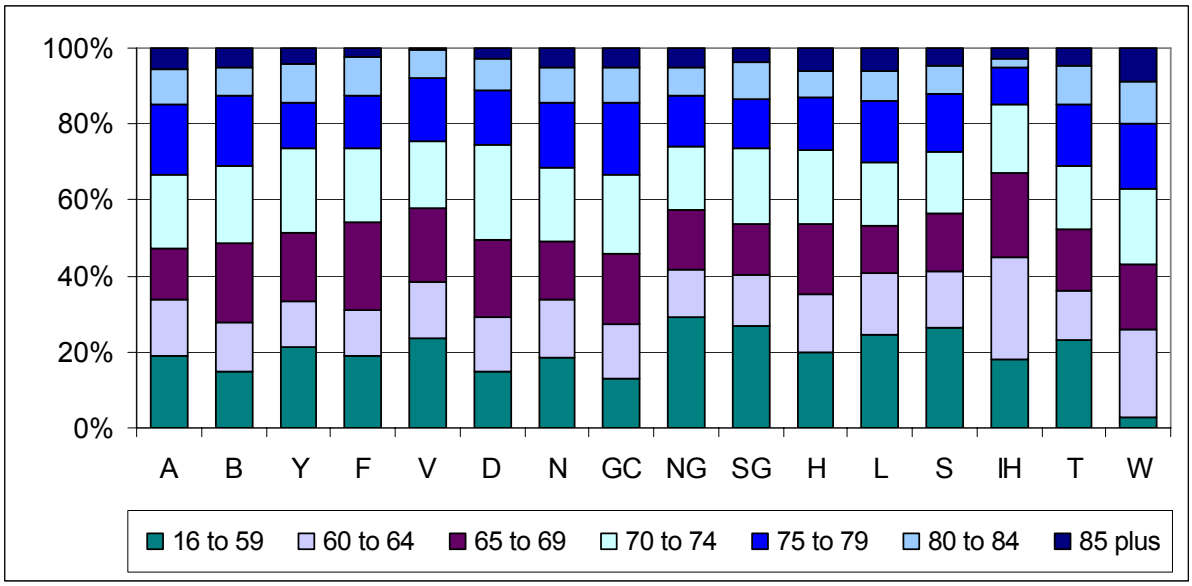
Laterality	Number of Patients
Unknown	990
Left	2916
Right	2338
Bilateral	34
Total	6278

Table 10: Number of hip replacements for the last five years split by NHS Board

	Number of operations				
NHS Board of treatment	2003/04	2004/05	2005/06	2006/07	2007/08
Ayrshire and Arran	318	308	309	344	388
Argyll & Clyde	212	187	198	-	-
Borders	163	152	136	134	136
Dumfries and Galloway	109	104	113	116	117
Fife	317	304	331	390	391
Forth Valley	159	158	176	175	190
Golden Jubilee	349	370	487	537	631
Grampian	609	624	742	749	779
Greater Glasgow and Clyde					
- Clyde	-	-	-	199	243
- North Glasgow	431	442	631	658	673
- South Glasgow	218	251	300	303	279
Highland	404	462	478	554	449
Lanarkshire	361	329	405	434	343
Lothian	535	712	881	1022	867
Independent hospitals[1]	53	56	131	135	116
Tayside	560	530	648	760	675
Western Isles	61	47	44	49	35
Total	4859	5036	6010	6559	6312

1 – Not all figures for Independent hospitals available.

Figure 20 : Percentage patient age range splits for each NHS Board of treatment



Abbreviation	NHS Board	Abbreviation	NHS Board
A	Ayrshire and Arran	B	Borders
Y	Dumfries and Galloway	F	Fife
V	Forth Valley	D	Golden Jubilee
GC	Glasgow Clyde	N	Grampian
NG	North Glasgow	H	Highland
SG	South Glasgow	L	Lanarkshire
S	Lothian	T	Tayside
W	Western Isles	IH	Independent Hospitals

1.5. Knee Replacements

Table 11: Number of patients who have undergone a knee replacement in 2007/08 split by sex

Sex	Number of Patients	Median Age
Male	2566	69
Female	3526	70
Total	6092	70

Figure 21: Patient numbers and median age split by gender over 10 years

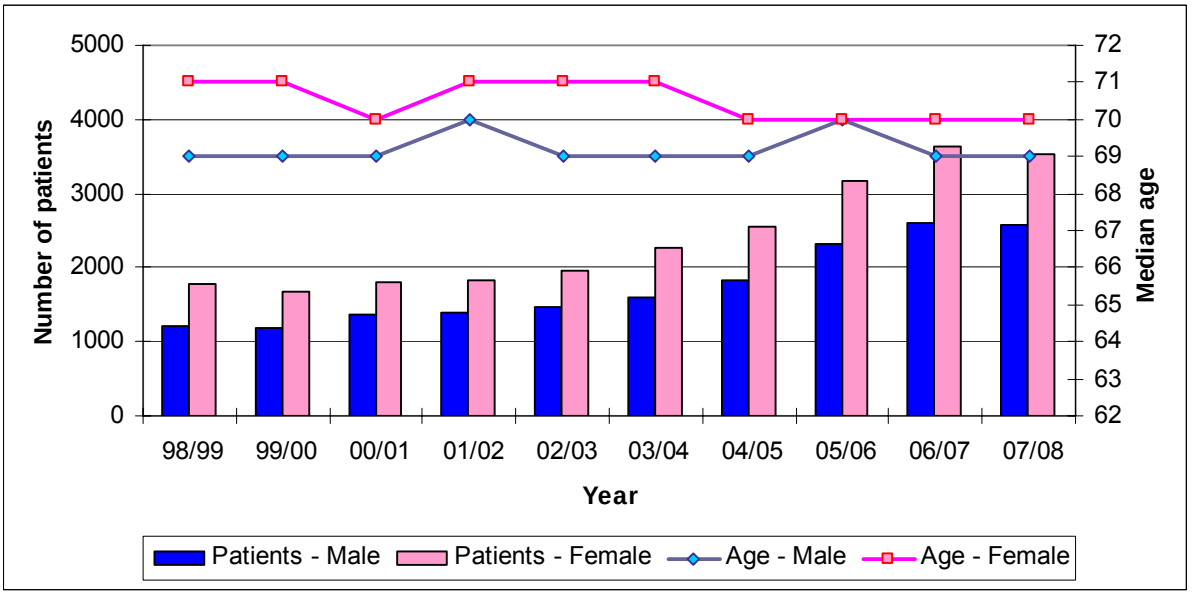


Table 12 : Deprivation category of patients by age

	Number of patients by age range							
Deprivation category	16 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 to 84	85 plus	Total
1	153	174	224	260	229	133	43	1216
2	193	181	280	275	221	123	34	1307
3	217	175	242	239	237	114	36	1260
4	202	182	226	255	203	104	36	1208
5	202	179	200	234	182	70	25	1092
Not known	3	2	1	1	1	1	-	9
Total	970	893	1173	1264	1073	545	174	6092

Table 13: Laterality of knee replacement

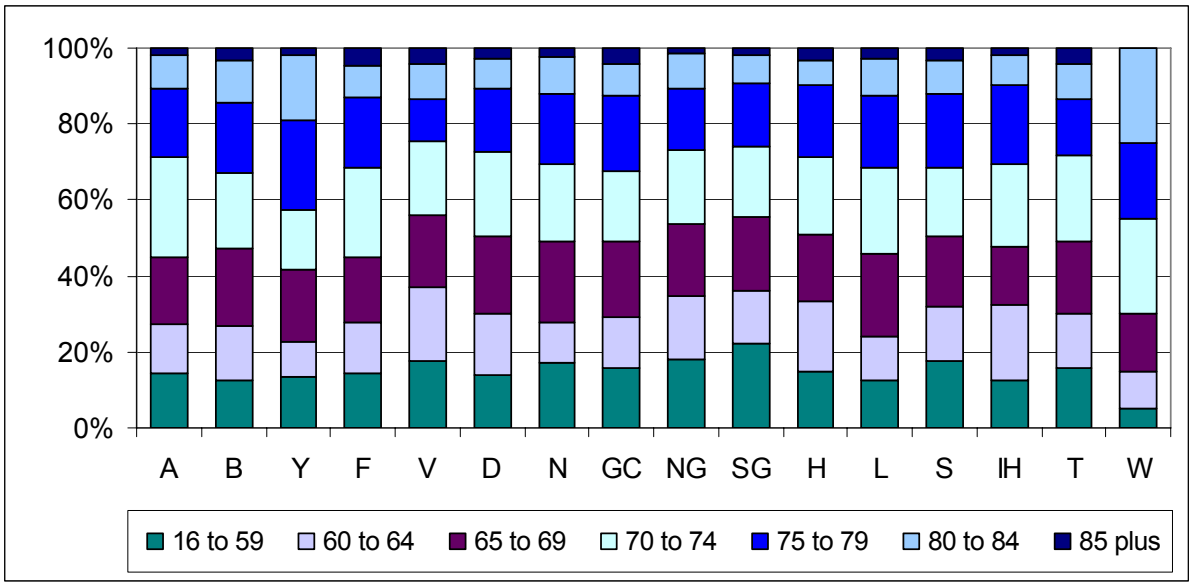
Laterality	Number of Patients
Unknown	710
Left	2812
Right	2502
Bilateral	68
Total	6092

Table 14: Number of knee replacements for the last five years split by NHS Board

	Number of operations				
NHS Board of treatment	2003/04	2004/05	2005/06	2006/07	2007/08
Ayrshire and Arran	317	288	322	293	288
Argyll & Clyde	178	184	234	-	-
Borders	102	98	95	121	119
Dumfries and Galloway	70	77	87	102	120
Fife	284	306	331	446	426
Forth Valley	146	119	167	177	245
Golden Jubilee	319	416	579	716	912
Grampian	413	384	523	562	550
Greater Glasgow and Clyde					
- Clyde	-	-	-	267	245
- North Glasgow	434	492	638	786	729
- South Glasgow	232	269	362	330	352
Highland	288	328	429	444	354
Lanarkshire	308	323	376	439	340
Lothian	403	675	819	929	789
Independent hospitals[1]	72	69	118	150	105
Tayside	368	451	491	566	566
Western Isles	8	19	9	17	20
Total	3942	4498	5580	6345	6160

1 – Not all figures for Independent hospitals available.

Figure 22 : Percentage patient age range splits for each NHS Board treatment



Abbreviation	NHS Board	Abbreviation	NHS Board
A	Ayrshire and Arran	B	Borders
Y	Dumfries and Galloway	F	Fife
V	Forth Valley	D	Golden Jubilee
GC	Glasgow Clyde	N	Grampian
NG	North Glasgow	H	Highland
SG	South Glasgow	L	Lanarkshire
S	Lothian	T	Tayside
W	Western Isles	IH	Independent Hospitals

9. Clinical Governance Policy and Results

Clinical Governance: “A framework through which NHS organisations are accountable for continually improving the quality of their services and safeguarding high standards of care by creating an environment in which excellence in clinical care will flourish.”

Scally G. & Donaldson L.J. BMJ 1998:317 61-65.

Since its inception, the policy of the Scottish Arthroplasty Project has been to provide high quality data on activity and complications, which can be used at a local level to promote change and assist consultant appraisal. Simple monitoring of activity and quality may influence clinical practice but can be insufficient to create significant change. With the support of the SCOT committee a feedback and review system was introduced at NHS Board and consultant level to look at quality issues, which appeared to vary from national standards. A full account of the process and definitions can be found in the 2007 report.

1.6. Consultant Outliers

Every consultant outlier is requested to investigate the accuracy of the data and the clinical features of each case. They are asked to comment on their cases and provide an action plan if any issues are found.

The introduction of a new technique, a new implant or particular case mix issues may be identified. It is essential that the completed response be co-signed by a consultant colleague as verification. The response is then assessed by the committee anonymously and scored as to its relevance. If the response is unsatisfactory then a resubmission addressing any discrepancy is requested. The process is anonymous with no members of the committee knowing the source of any response or recipient of the review.

Table 15: Summary of consultant outliers

Report Year	5 Year Time Period	New Outliers	Outlying for 2 years	Outlying for 3 years	Outlying for 4 years	Outlying for 5 years	Total Outlying consultants
2003	April 1996 - March 2001	15	-	-	-		15
2004	April 1997 - March 2002	10	4	-	-		14
2005	April 1998 - March 2003	6	6	2	-		14
2006	April 1999 - March 2004	14	3	2	1		20
2007	April 2000 - March 2005	8	6	1	1		16
2008	April 2001 - March 2006	15	4	4	1	1	25
2009	April 2002 - March 2007	15	7	2	2	1	27

For statistical precision, the figures are derived over five years. It is therefore inevitable that some outliers continue to be identified until their five-year average returns to within normal variation. In 2009, 15 new outliers, two three-year outliers and one five-year outlier, currently in practice in NHS Scotland, will be invited to respond in the coming year. They will be notified in June 2009 and will be expected to respond by September 2009.

Table 16: Summary of consultant outlier responses

Report Year	consultant numbers	Response	Exemplary	Excellent	Satis-factory	Less than satisfactory	Late response awaiting review	Referred to Chief Executive
2003	15	15	N/A	N/A	14	1	-	-
2004	10	10	N/A	N/A	7	3	-	-
2005	6	6	3	1	2	-	-	-
2006	16	16	3	9	4	-	-	-
2007	9	8	-	6	2	-	-	-
2008	20	14	-	7	6	1	1	-

In 2008, there were fifteen new consultant outliers, four consultants who were outlying for three years and one who was outlying for five years.

1.7. NHS Board Outliers

A similar process is followed with NHS Board data, where the information is sent to the Chief Executive. Following an appropriate investigation the Action Plan is co-signed by the Chief Executive and the appropriate Clinical Director (further information can be found in the 2004 Annual Report – section 6.2.2).

Table 17: Summary of NHS Board Outliers

Report Year	5 Year Time Period	Outlying Boards	New Outliers	Outlying for 2 years	Outlying for 3 years	Outlying for 4 years	Outlying for 5 years	Outlying for 6 years	Outlying for 7 years
2003	April 1996 - March 2001	4	4	-	-	-	-	-	-
2004	April 1997 - March 2002	5	2	3	-	-	-	-	-
2005	April 1998 - March 2003	4	1	-	3	-	-	-	-
2006	April 1999 - March 2004	4	2	-	-	2	-	-	-
2007	April 2000 - March 2005	5	2	1	-	-	2	-	-
2008	April 2001 - March 2006	6	3	-	1	-	-	2	-
2009	April 2002 - March 2007	4	-	2	-	1	-	-	1

The initial response to the 2003 data was disappointing, only one NHS Board responding within the time frame and one has not responded to date. In keeping with the previous structure created to deal with non-compliance the Chief Executive was informed and action

taken. Two of the three responses were regarded as less than satisfactory. In 2004, both NHS Boards responded and they were classified as satisfactory. In 2005 all NHS Boards responded satisfactorily. In 2006, both NHS Boards responded; one response was satisfactory and the other was deemed to be excellent. In keeping with the SAP policy all outlying NHS Boards for three consecutive years were asked to review the data. In 2008, all NHS Boards responded, however at the time of publication not all action plans have been scored.

Evidence of Care Improvement

It is difficult to confirm that observation and report change practice, indeed any change is likely to be multifactorial. However, elsewhere in this report there are charts showing improvement in the outcomes for DVT, death and dislocation since the inception of the project and its feedback process. The Scottish Surveillance of Healthcare Associated Infection Programme (SSHAIP) has independently shown a significant and beneficial change in the infection rates following total hip replacement since the inception of the project. The numbers of procedures carried out by low volume surgeons has decreased and the revision rate for hip surgery has remained static.

10. Complication Rates for Hip and Knee Replacements

For the sixth year, complication data are presented for four different outcomes following elective primary hip or knee replacement:

- dislocation of the joint within 365 days following surgery (for hips only);
- infection (both superficial and deep) of the joint within 365 days following surgery;
- death within 90 days following surgery; and
- deep vein thrombosis/pulmonary embolism (DVT/PE) within 90 days following surgery.

Also, national revision rates within 365 days for both hip and knee replacements are included this year for the first time.

In previous years, these data have been presented using control that displayed the complication data simply by plotting the number of complications against the number of procedures performed charts (see section 5.1.3. of the 2004 Annual Report). It was decided to develop this analysis by standardising the data for case mix, using all the possible variables available on the national dataset. Since the 2005 Annual Report, all the data have been standardised for:

- age;
- sex;
- admission from home or other place of residence (e.g. nursing home);
- rheumatoid arthritis; and
- deprivation.

The standardised data are presented as complication rates, not as actual numbers of complications. This results in control charts that have a funnel shape to them (funnel plots).

This year, those consultants and NHS Boards that lie outside the upper control limit for the first time (three standard deviations above the expected complication rate) and those who have been outlying for three, five or seven years in a row will be invited to participate in a review of the cases making up this year's outlying number. The purpose of this is to review these figures under the umbrella of clinical governance, with the emphasis on quality improvement and not on attributing blame. Indeed, although we appear to analyse to a surgeon level, the data represents the whole process of care not just the actions of one individual. In many cases, the cause may be in the accuracy of the data, for example, coding problems, but it is still important to investigate this.

The diagnostic code used to identify an infected prosthesis does not differentiate between deep and superficial infection. This can often be difficult to determine clinically. The International Classification of Diseases (ICD-10) codes used to code medical records do not distinguish the severity of an infection.

Statistical Process Control Techniques And Identifying Special Variation

Statistical Process Control (SPC) techniques, when applied to measurement data, can be used to highlight areas that would benefit from further investigation. These techniques enable the user to identify variation within their process. Understanding this variation is the first step towards quality improvement.

Variation exists in all processes around us. The two types of variation are 'common cause' and 'special cause' variation.

Common Cause: All processes have random variation - known as 'common cause variation'. A process is said to be 'in control' if it exhibits only common cause variation i.e. the process is completely stable and predictable.

Special Cause: Unexpected events/unplanned situations can result in 'special cause variation'. A process is said to be 'out of control' if it exhibits special cause variation i.e. the process is unstable. SPC charts are a good way to identify between these types of variation and can be applied to both dynamic processes and static processes.

Dynamic Processes: A process that is observed across time is known as a dynamic process. An SPC chart for a dynamic process is often referred to as a 'time-series' or a 'longitudinal' SPC chart.

Static Processes: A process that is observed at a particular point in time is known as a static process. An SPC chart for a static process is often referred to as a 'crosssectional' SPC chart. A cross-sectional SPC chart is a good way to compare different institutions.

There are a number of suggested guidelines for identifying Special Cause Variation:

Number of Runs: If there are too few or too many runs in the process.

Shift: If the number of successive useful observations, falling on the same side of the centreline, is greater than 7.

Trend: If the number of successive useful observations, either increasing or decreasing, is greater than 7.

Zig-Zag: If the number of useful observations, decreasing and increasing alternately (creating a zig-zag pattern), is greater than 14.

Wildly different: If a useful observation is deemed as wildly different from the other observations. This rule is subjective and is easier to identify when interpreting control charts.

Cyclical Pattern: If a regular pattern is occurring over time – for example a seasonality effect.

There are two additional rules for identifying Special Cause Variation.

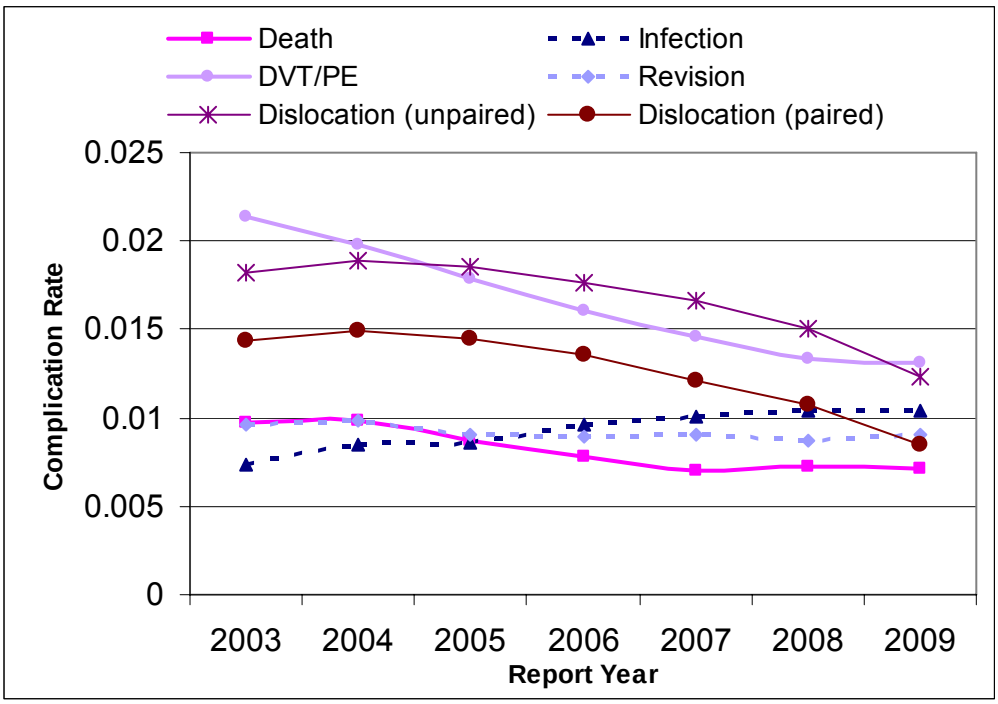
Control Limits: If there is one or more observation outwith the control limits.

Warning Limits: If there are two successive observations outwith the same warning limits.

1.8. NHS Board Data for Complications Following Elective Primary Hip Replacement

Figure 23 shows the national complication rates following total hip replacement for NHS Boards from 2003 to 2009 (includes data from 1st April 1996 to 31st March 2007) for deaths, dislocations, infections DVT/PE and revisions. There has been a steady decrease in the complication rates for deaths, dislocations and DVT/PE whilst the rate for infections and revisions has slightly increased.

Figure 23: National rates for complications following elective primary hip replacements from report year 2003 to 2009



In the 2008 Annual Report the definition of hip dislocations was redefined based on feedback from consultants and advice from coding experts. Prior to the 2008 Annual Report hip dislocations were defined using codes for hip dislocation and the more general procedure ‘‘Attention To Total Prosthetic Replacement Of Hip Joint, N.E.C.' (W394). For the 2008 Report this code was only used when paired with ‘Correction of displacement of prosthesis, not elsewhere classified’ (Y033). Two dislocation rates are displayed this year for dislocations using both the paired and unpaired definition.

1.9. Run Charts for Dislocations, DVT/PE and Infections Following Hip Replacement

In order to further assess changes in overall complication rates we include run charts showing the rates of complication by each quarter. Run charts allow analysis over time (local factors may lead to clusters of complications at particular periods even though overall complication rates are well within “accepted” limits).

Run charts showing the number of complications following hip replacement in each quarter between 1st April 2002 and 31st March 2007 are shown in Figure 24 to Figure 26. Dislocations, defined using both paired and unpaired coding, within 365 days and DVT/PE within 90 days of hip replacement have decreased over this period.

The quarter beginning 1st April to 30th June 2002, had a complication rate above the upper warning limit (UWL) in each complication type. Unpaired dislocation rate also exceeded the upper warning limit in the quarter beginning 1st July to 30th September 2004.

SAP introduced a Clinical Governance process in 2004, whereby consultants and NHS Boards are asked to review their complication rates. It is interesting to note that the complication rate for hip dislocations decreased following this change. DVT/PE has also decreased for this time, although to a lesser extent.

Figure 24: Run chart for paired dislocations within 365 days of hip replacement between 1st April 2002 and 31st March 2007

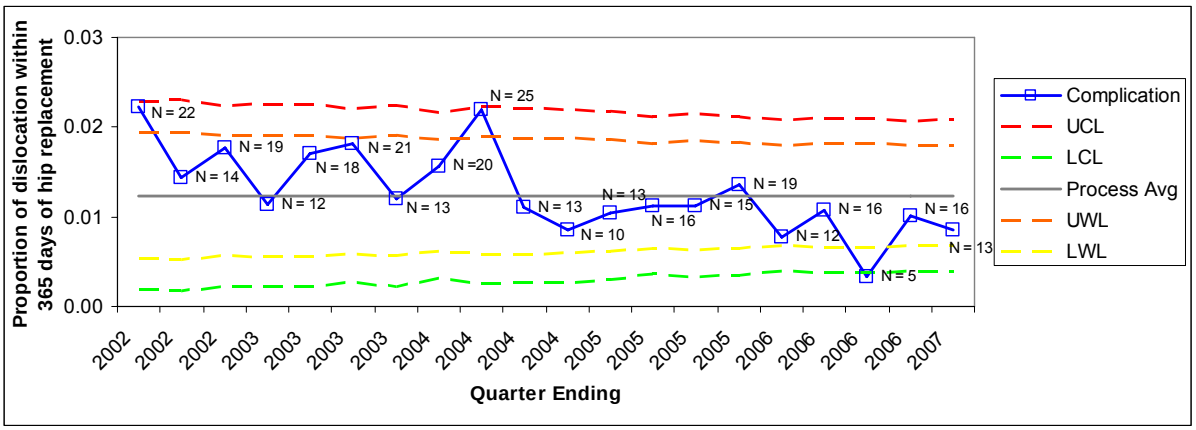


Figure 25: Run chart for unpaired dislocations with in 365 days of hip replacement between 1st April 2002 and 31st March 2007

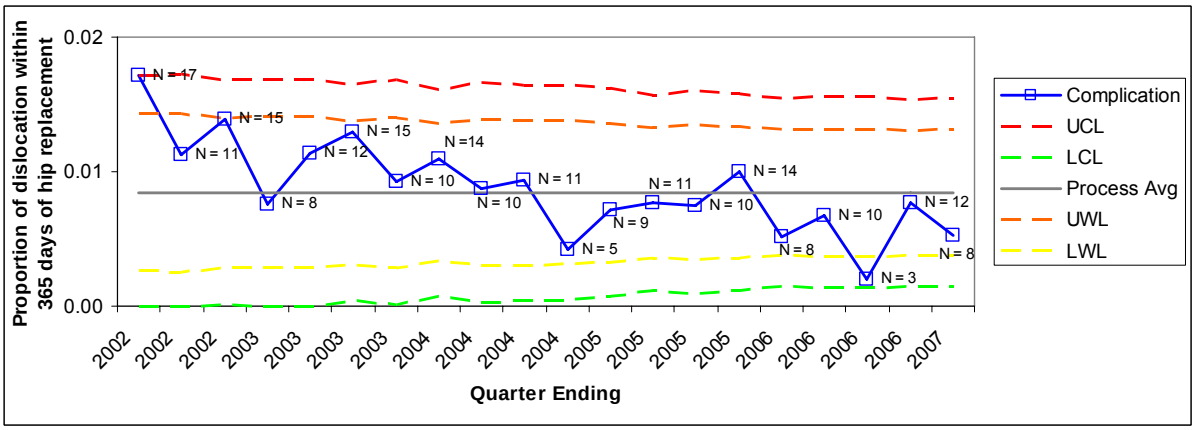


Figure 26: Run chart for DVT/PE within 90 days of hip replacement between 1st April 2002 and 31st March 2007

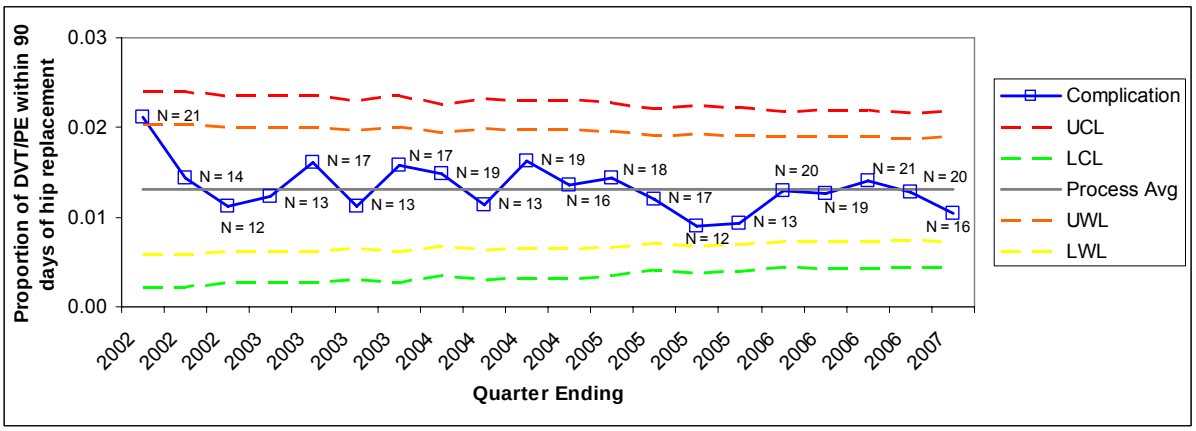
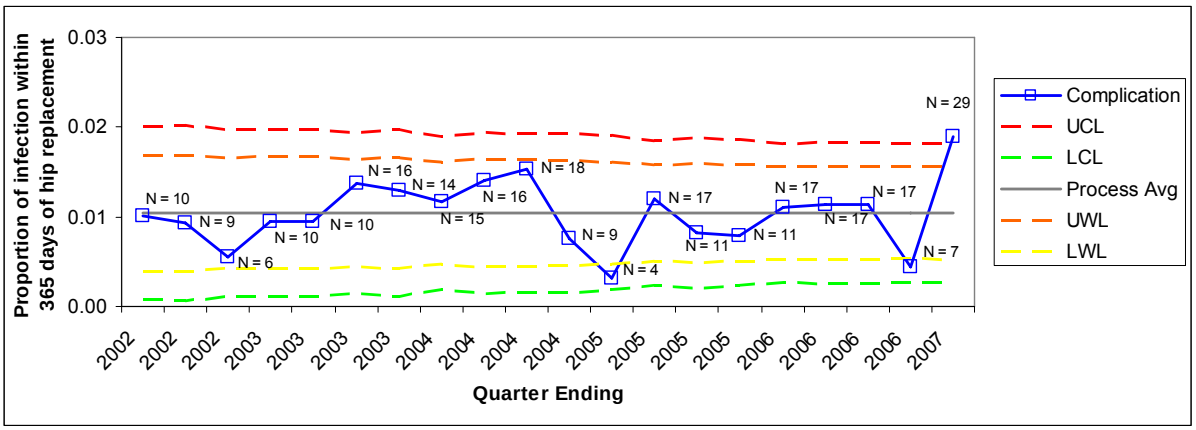


Figure 27: Run chart for infection within 365 days of hip replacement between 1st April 2002 and 31st March 2007



1.10. NHS Board Data for Complications Following Elective Primary Hip Replacement (April 2002 – March 2007)

As part of the Clinical Governance process, NHS Boards are contacted when the complication rate is above the Upper Control Limit for infections, dislocations and DVT/PE. Figure 28 to Figure 31 represent the complication rates for elective hip replacement between April 2002 and March 2007. Each data point represents the complication rate for an NHS Board in Scotland (for the label key and explanation of features see page 31). NHS Boards that were outlying both last year and this year have been marked with a circle and will not be asked to repeat the governance process. Also, the NHS Boards that were outlying last year, but not this year, have been marked with a square. NHS Boards that have been outlying for three years have been marked with a diamond, those that have been outlying for four years have been marked with a triangle, NHS Boards outlying for five years have been marked with a cross, NHS Boards which have been outlying for six years have been marked with a solid diamond, whilst NHS Boards that have been outlying for seven years have been marked with a white cross on a blue background.

Key to NHS Board Ciphers

A: Ayrshire and Arran
B: Borders
C: Argyle and Clyde
D: Golden Jubilee National Hospital
F: Fife
H: Highland
L: Lanarkshire
N: Grampian
S: Lothian
T: Tayside
V: Forth Valley
W: Western Isles
Y: Dumfries and Galloway
Greater Glasgow and Clyde
GC: Clyde
NG: North Glasgow
SG: South Glasgow

Key to the Features of the Control Charts – this applies to all Funnel Plots in this report

——— Upper and Lower Control Limits

——— Scottish Mean

X NHS Board or consultant

□ NHS Board or consultant outlying last year, but not this year

⊗ NHS Board or consultant outlying for a second year in a row

◊ NHS Board or consultant outlying for a third year in a row

△ NHS Board or consultant outlying for a fourth year in a row

✦ NHS Board or consultant outlying for a fifth year in a row

◆ NHS Board or consultant outlying for a sixth year in a row

⊠ NHS Board or consultant outlying for a seventh year in a row

Figure 28: Observed and expected standardised rates of deaths within 90 days

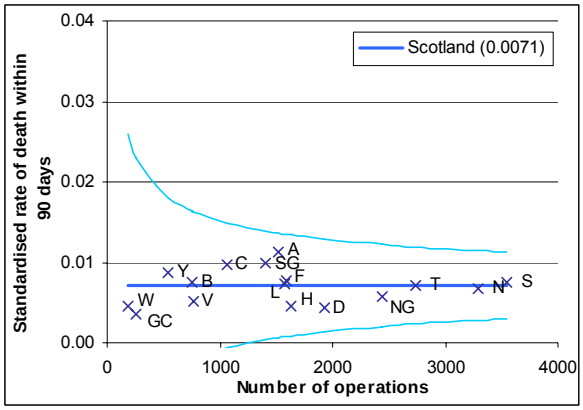


Figure 30: Observed and expected standardised rates of hip dislocations (paired) within 365 days

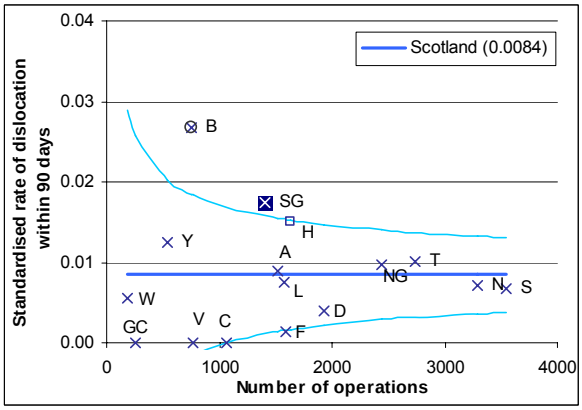


Figure 29: Observed and expected standardised rates of joint infections within 365 days

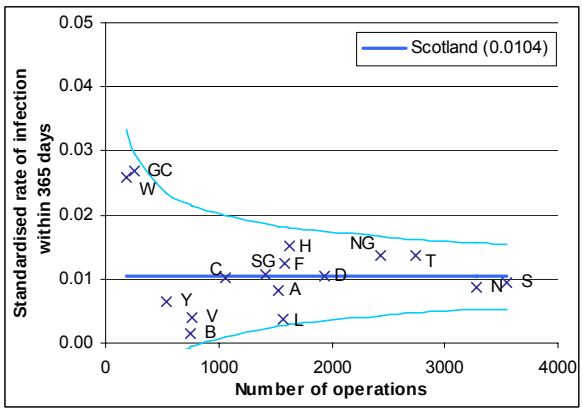
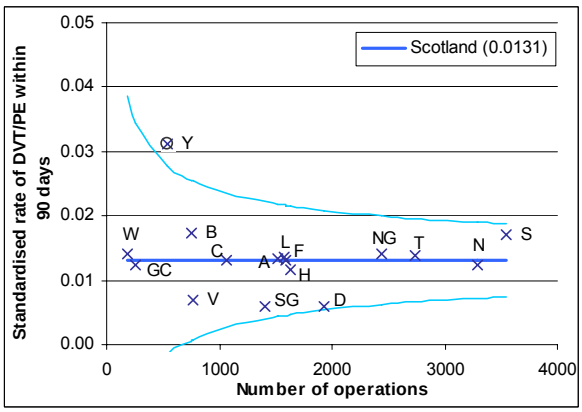


Figure 31: Observed and expected standardised rates of DVT/PE within 90 days



Orkney and Shetland are not included as their patients undergo elective arthroplasty surgery in NHS Grampian and are included in the Grampian data.

1.11. Consultant Surgeon Data for Complications Following Elective Primary Hip Replacement (April 2002 – March 2007)

Figure 32 to Figure 35 represent the complication rates following elective hip replacement between April 2002 and March 2007. Each data point represents the complication rate for each consultant in Scotland. For a key to the features of the charts please see page 30. Those consultants who are outlying for the first time and those outlying for a third, fifth year or seventh year in a row will be contacted to explore the reasons for these complication rates. The consultants who are outlying for a second or fourth year in a row will not be asked to reinvestigate the data, but will be monitored over the forthcoming years. This is due to the historical nature of the data and the fact that it is five years aggregated data, which would take some time to show change in complication rates.

Because the charts show standardised rates of complications, those surgeons with low numbers of index procedures may have only one complication but this causes a high rate. To account for this the charts show control limits within which variation is likely to be statistical due to low numbers rather than a problem with care. All surgeons (and hospitals), particularly those with low numbers and high complication rates, should pay particular attention to each individual case.

The distribution of complication rates (y axis) on our charts are strongly skewed towards zero. As such, the complication rates are presented on a logarithmic scale. Presenting the complication rates on a logarithmic scale has the effect of reducing skewness, making the distribution more normal. The data points have not changed, only the scale on the chart, making interpretation easier.

Figure 32: Observed and expected standardised rates of deaths within 90 days (logarithmic scale)

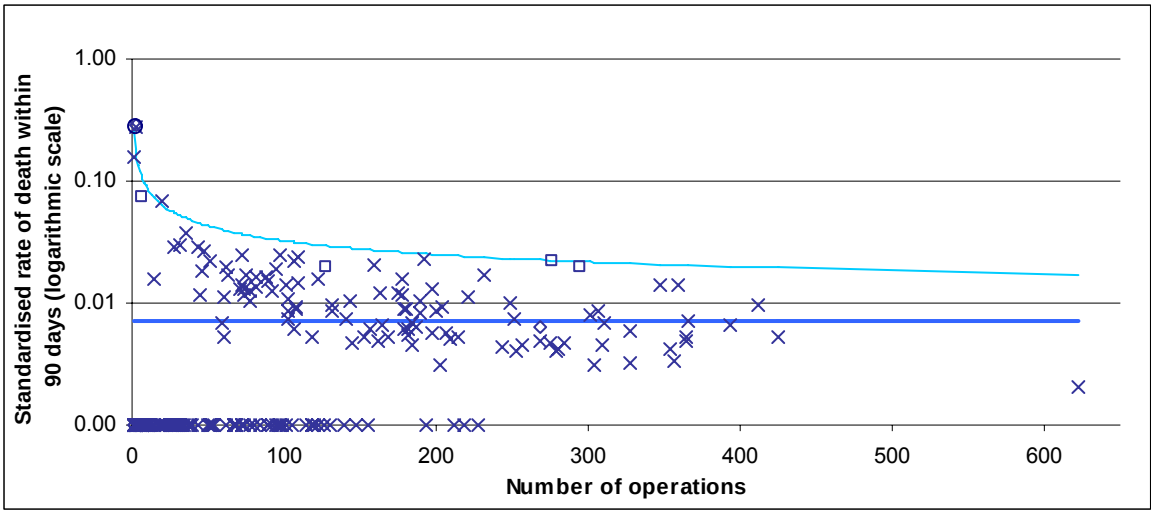


Figure 33: Observed and expected standardised rates of hip dislocations within 365 days (logarithmic scale)

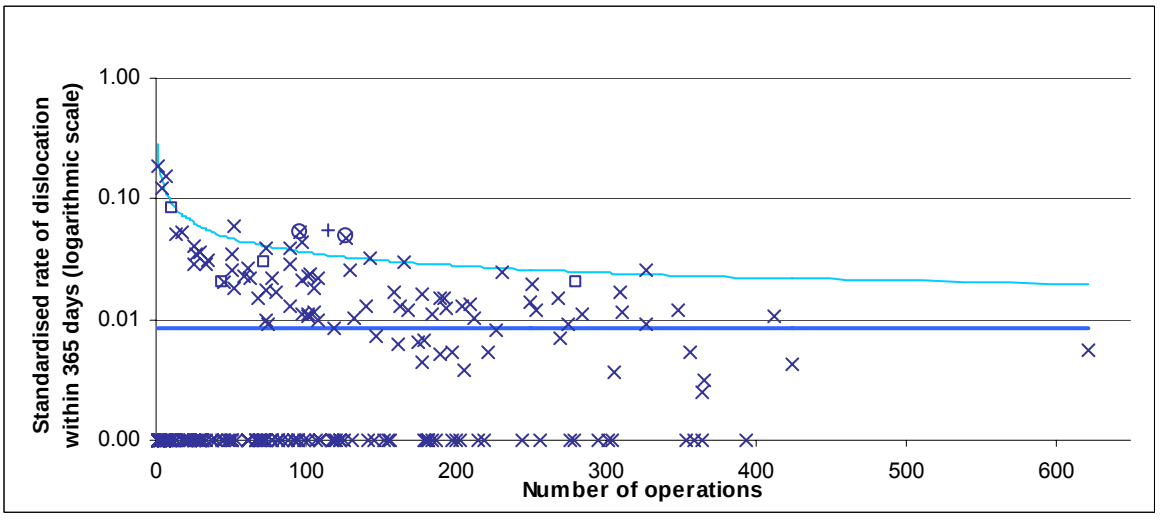


Figure 34: Observed and expected standardised rates of joint infections within 365 days (logarithmic scale)

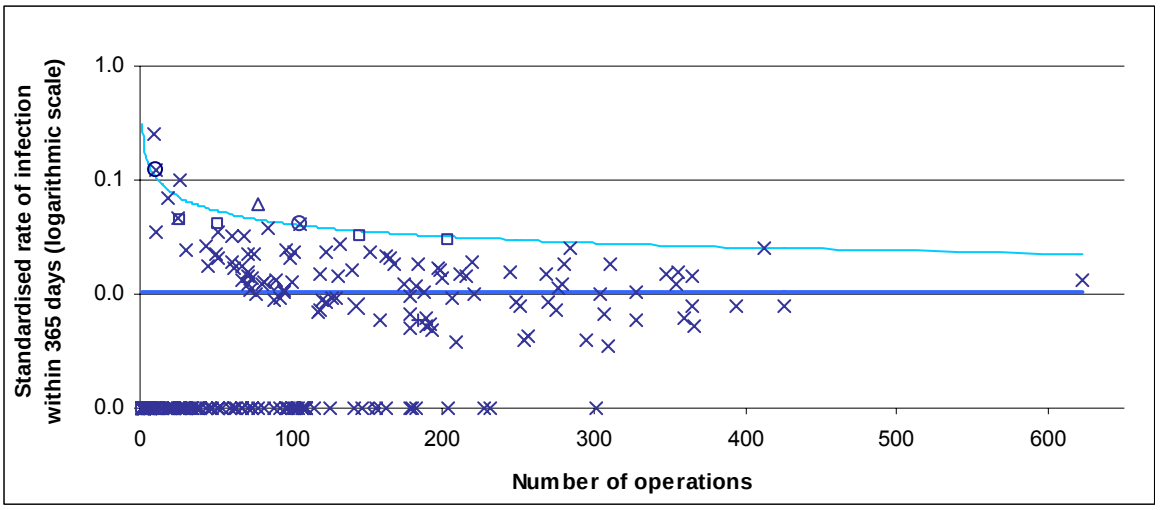
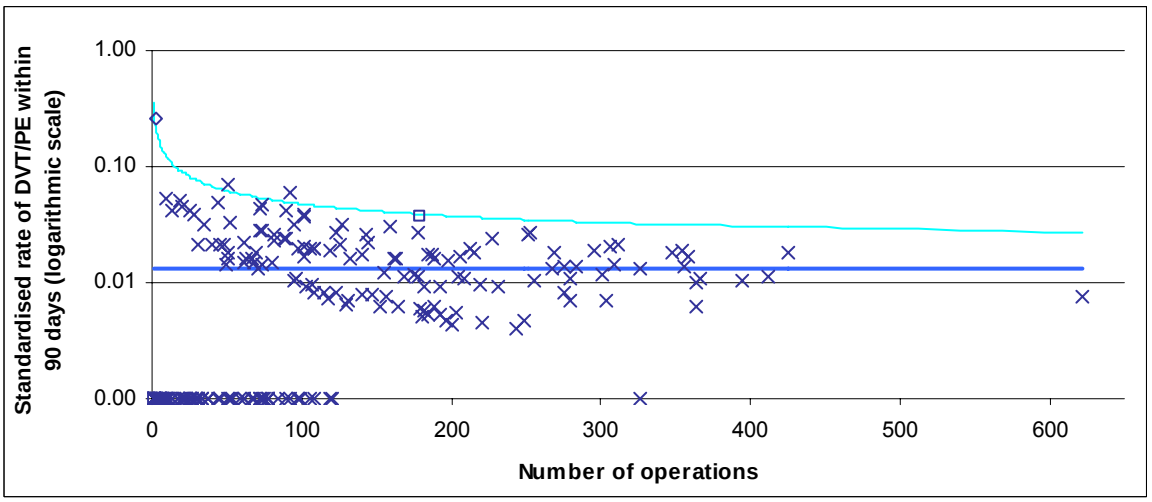


Figure 35: Observed and expected standardised rates for DVT/PE within 90 days (logarithmic scale)



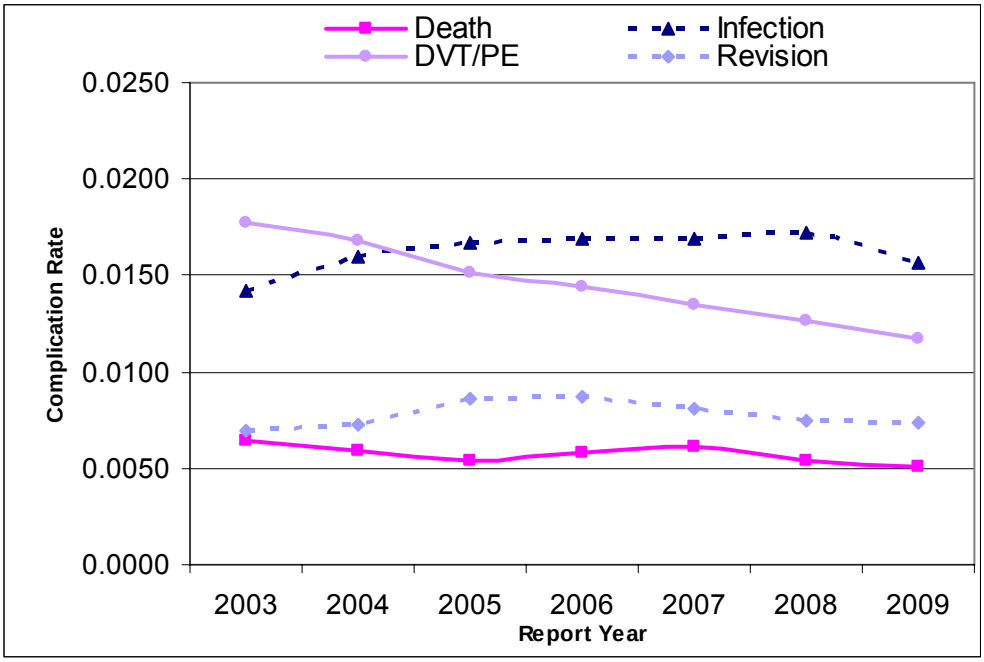
1.12. NHS Board Data for Complications Following Elective Primary Knee Replacement

Figure 36 compares the national complication rates following knee replacement for NHS Boards for report years 2003 to 2009 (includes data from 1st April 1996 to 31st March 2007), for deaths, knee revisions, infections and DVT/PE. Complication rates for DVT/PE, revisions and deaths have decreased, however rates for infections has slightly increased.

Figure 39 to Figure 40 represent the complication rates for elective knee replacement between April 2002 and March 2007. Each data point represents the complication rate for an NHS Board in Scotland (for the label key and explanation of features see page 30). The NHS Boards that are outlying for the first time and those outlying for a third year, fifth year or seventh year in a row will be contacted to explore the reasons for these complication rates.

Those NHS Boards that are outlying for a second, fourth or sixth year in a row will not be asked to reinvestigate the data, but will be monitored over the forthcoming years. This is due to the historical nature of the data and the fact that it is five years aggregated data that would take some time to show change in complication rates

Figure 36: National rates for complications following elective primary knee replacements from report year 2003 to 2009



1.13. Run Charts for DVT/PE and Infections following Knees Replacement

Run charts showing the number of complications following knee replacement in each quarter between 1st April 2002 and 31st March 2007 are shown in Figure 37 to Figure 38. Dislocations, defined using both paired and unpaired coding, within 365 days and DVT/PE

SAP introduced a Clinical Governance process in 2004, whereby consultants and NHS Boards are asked to review their complication rates. There has not been considerable change to the complication rate for DVT/PE over time. However, it is interesting to note that the complication rate for infections are now closer to the process average since the new Clinical Governance policy was introduced.

Figure 37: Run chart for DVT/PE within 90 days of knee replacement between 1st April 2002 and 31st March 2007

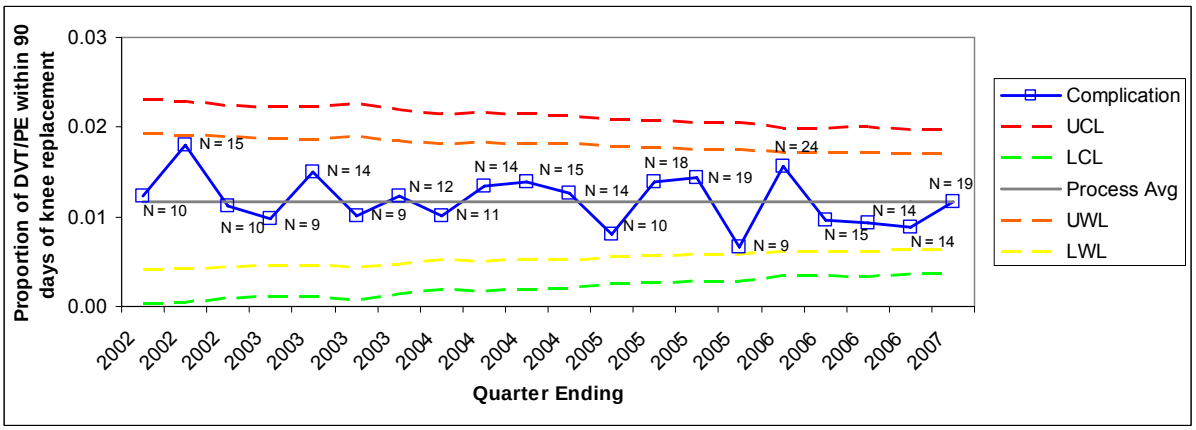
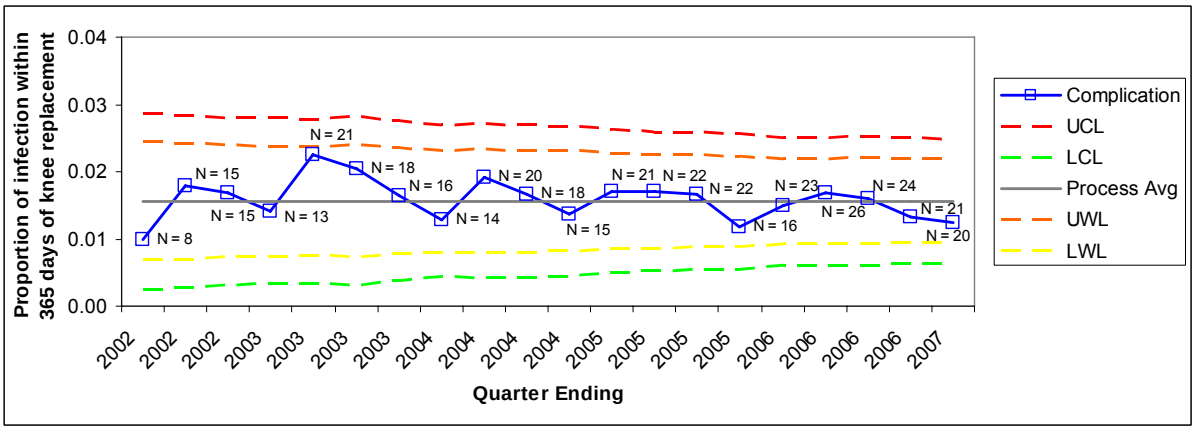


Figure 38: Run chart for infection within 365 days of knee replacement between 1st April 2002 and 31st March 2007



1.14. NHS Board Data for Complications Following Elective Primary Knee Replacement (April 2002 – March 2007)

NHS Boards are contacted when the complication rate is above the Upper Control Limit for infections, dislocations and DVT/PE. NHS Boards that were outlying both last year and this year have been marked with a circle and will not be asked to repeat the governance process. Also, the NHS Boards that were outlying last year, but not this year, have been marked with a square. NHS Boards that have been outlying for three years have been marked with a diamond, those that have been outlying for four years have been marked with a triangle, NHS Boards outlying for five years have been marked with a cross, NHS Boards which have been outlying for six years have been marked with a solid diamond, whilst NHS Boards that have been outlying for seven years have been marked with a white cross on a blue background.

Figure 39: Observed and expected standardised rates of deaths within 90 days

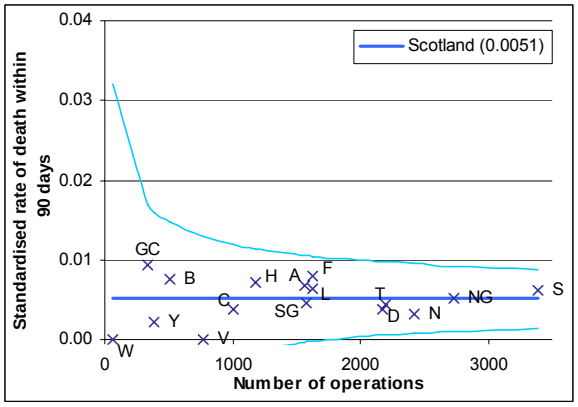


Figure 41: Observed and expected standardised rates of joint infections within 365 days

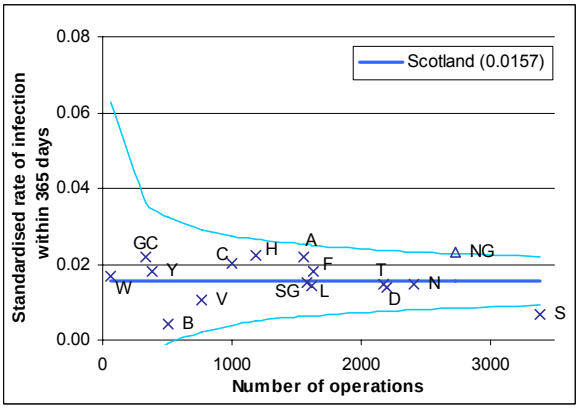
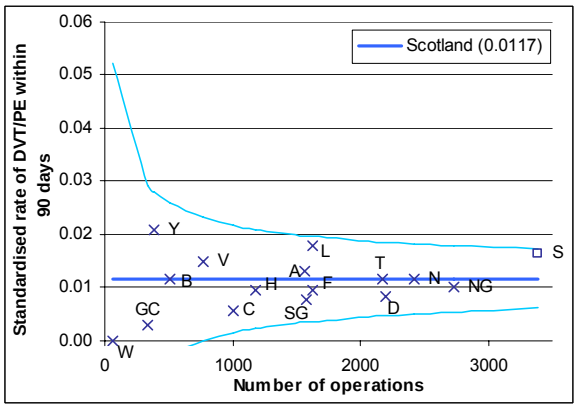


Figure 40: Observed and expected standardised rates of DVT/PE within 90 days



1.15. Consultant Surgeon Data for Complications Following Elective Primary Knee Replacement (April 2002 – March 2007)

Figure 42 to Figure 44 represent the complication rates for elective knee replacement between April 2002 and March 2007. Each data point represents the complication rate for a consultant in Scotland. For a key to the features of the charts please see page 30. Those consultants who are outlying for the first time and those outlying for a third, fifth or seventh year in a row will be contacted to explore the reasons for these complication rates. The consultants who are outlying for a second, fourth or sixth year in a row will not be asked to investigate the data, but will be monitored over the forthcoming years. This is due to the historical nature of the data and the fact that it is five years aggregated data, which would take some time to show change in complication rates.

Consultants that were outlying both last year and this year have been marked with a circle and will not be asked to repeat the governance process. Also, the consultants that were outlying last year, but not this year, have been marked with a square. Consultants that have

been outlying for three years have been marked with a diamond, those that have been outlying for four years have been marked with a triangle, consultants outlying for five years have been marked with a cross, consultants which have been outlying for six years have been marked with a solid diamond, whilst consultants that have been outlying for seven years have been marked with a white cross on a blue background.

The distribution of complication rates (y axis) on our charts are strongly skewed towards zero. As such, the complication rates are presented on a logarithmic scale. Presenting the complication rates on a logarithmic scale has the effect of reducing skewness, making the distribution more normal. The data points have not changed, only the scale on the chart, making interpretation easier.

Figure 42: Observed and expected standardised rates of deaths within 90 days (logarithmic scale)

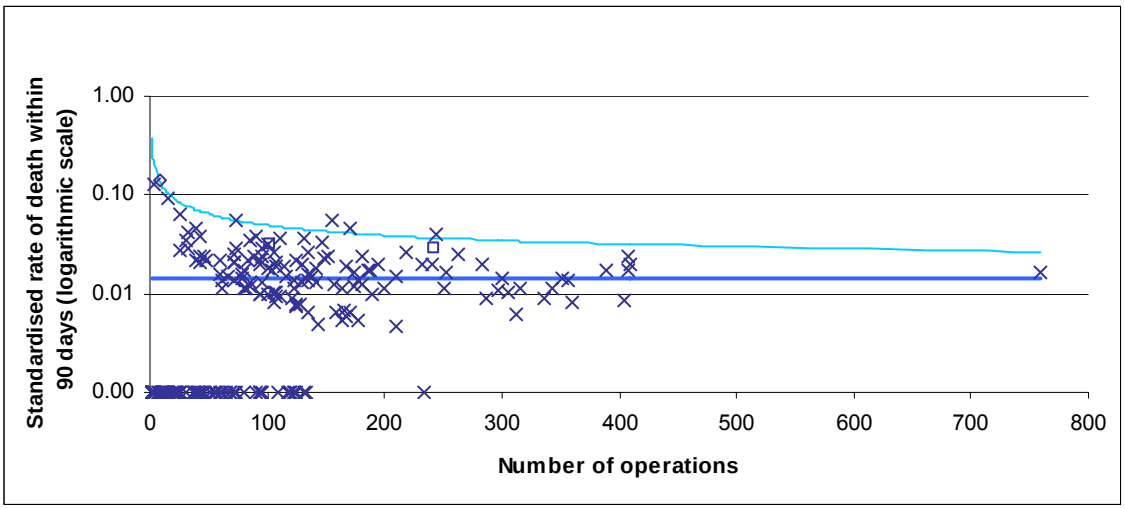


Figure 43: Observed and expected standardised rates of joint infections within 365 days (logarithmic scale)

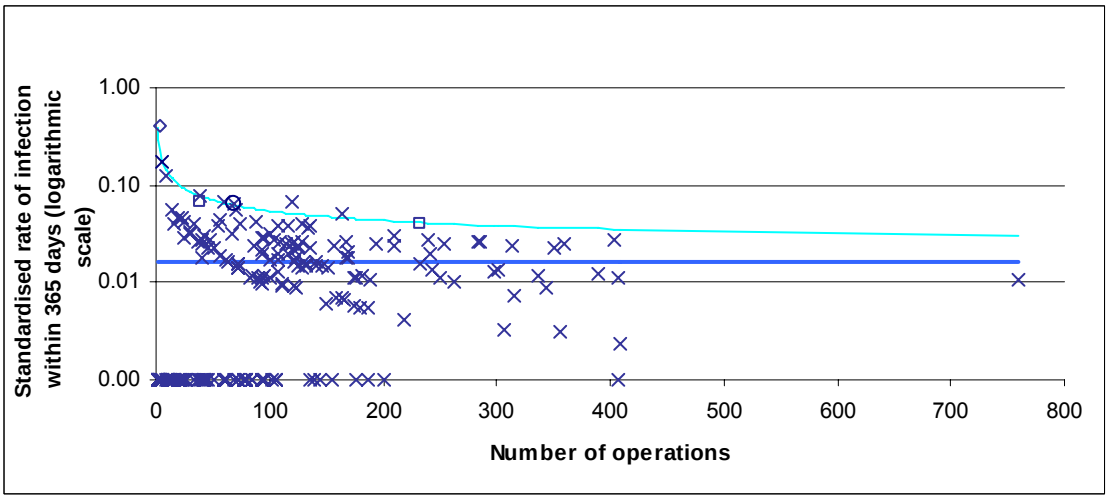
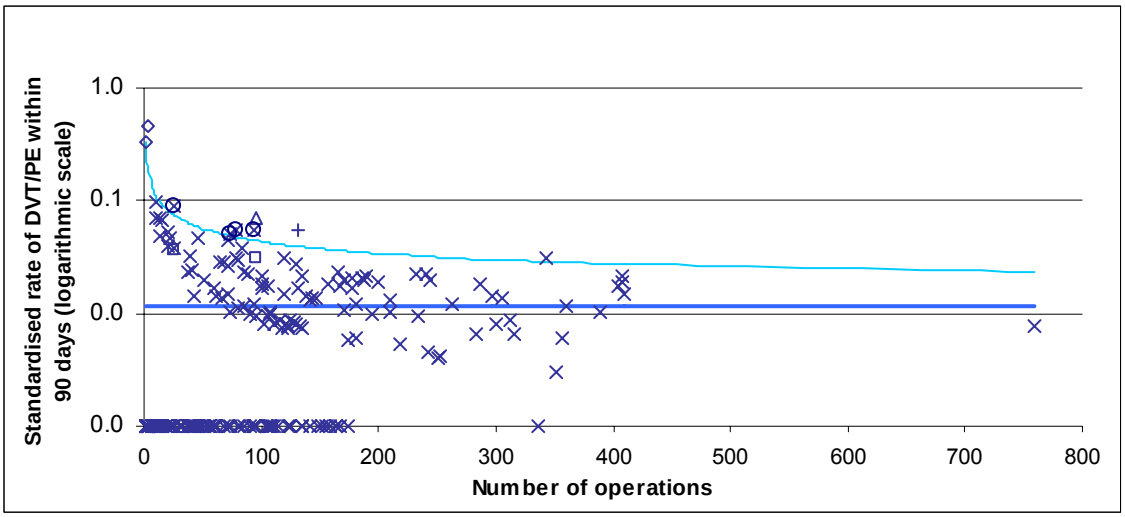


Figure 44: Observed and expected standardised rates of DVT/PE within 90 days (logarithmic scale)



11. Anaesthetic Complications

The Royal College of Anaesthetists Board in Scotland agreed to participate in the Scottish Arthroplasty Project. A multidisciplinary approach to the care of patients undergoing joint replacement is instrumental to their optimal management. Perioperative complications are usually multi-factorial but there is no doubt that pre operative assessment of risk and anaesthesia make a key contribution to outcome. The Scottish Arthroplasty Project provides the most accurate available information for anaesthetists and their patients undergoing such procedures in Scotland.

All primary and revision hip and knee replacements carried out in Scotland between the 1st April 2002 and 31st March 2007 were extracted from the Scottish Morbidity Records (SMR). All patients who were admitted to hospital with a complication following surgery were also extracted from the SMR within the same date range. The final analysis for this report is based on patients who developed a complication within 30 days of surgery.

1.16. Changes to the 2009 report

As in the 2008 Annual Report, complications investigated reflected the major concerns for patients and anaesthetists alike. All were linked to the 30 days post-operatively. They were:

- Acute myocardial infarction
- CVA/stroke
- Acute renal failure

The control charts showing the standardised rates for mortality and DVT/PE are also relevant to the investigations of anaesthetic complications (see Figure 45 to Figure 56). For each outcome, control charts are presented for both primary and revision hip and knee replacements. The upper control limit is three standard deviations above the expected complication rate. This year, all the data have been standardised for;

- age;
- sex;
- admission from home or other place of residence (e.g. nursing home);
- rheumatoid arthritis; and
- deprivation.

NHS Board specific reports will be sent out to the Clinical Directors of Anaesthetics of every hospital performing joint replacements. These reports contain information on the NHS Board's observed and expected rates for the above complications following primary and revision hip and knee replacement. It is important to emphasise that reviewing the

complication rates is undertaken on a departmental basis. Because such complications are relatively infrequent and relatively large numbers of anaesthetists undertake arthroplasty procedures, meaningful analysis of events would not necessarily be possible for individual anaesthetists. In addition, some complications may occur after the patient has left the care of the anaesthetist and they may be unaware of the problem

It is apparent that few anaesthetic departments are "outliers" for any of the complications investigated. Although this is, at face value reassuring for patients and anaesthetists, it may be that the local review of patients suffering complications may identify potential areas for improvement in areas such as preoperative assessment, patient selection, and the detection and subsequent treatment of such complications.

Please note that the scales in the graphs displayed below differ.

Key to NHS Board Ciphers

A:	Ayrshire and Arran	B:	Borders	Greater Glasgow and Clyde	
C:	Argyle and Clyde	D:	Golden Jubilee National Hospital	GC:	Clyde
F:	Fife	H:	Highland	NG:	North Glasgow
L:	Lanarkshire	N:	Grampian	SG:	South Glasgow
S:	Lothian	T:	Tayside		
V:	Forth Valley	W:	Western Isles		
Y:	Dumfries and Galloway				

Figure 45: Standardised Rate for AMI within 30 days of a primary hip replacement

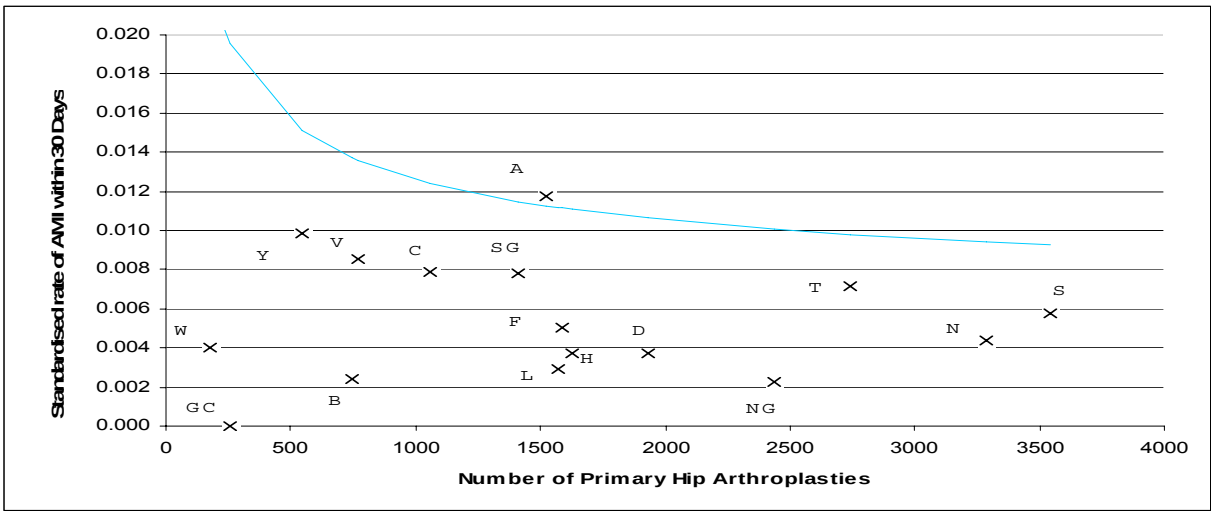


Figure 46: Standardised Rate for AMI within 30 days of a primary knee replacement

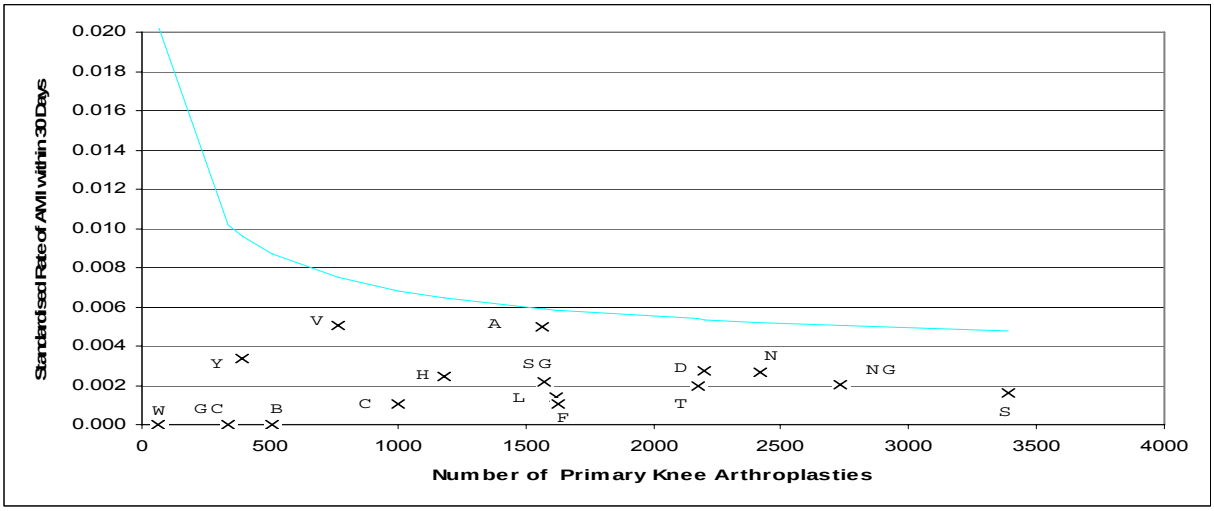


Figure 47: Standardised Rate for stroke within 30 days of a primary hip replacement

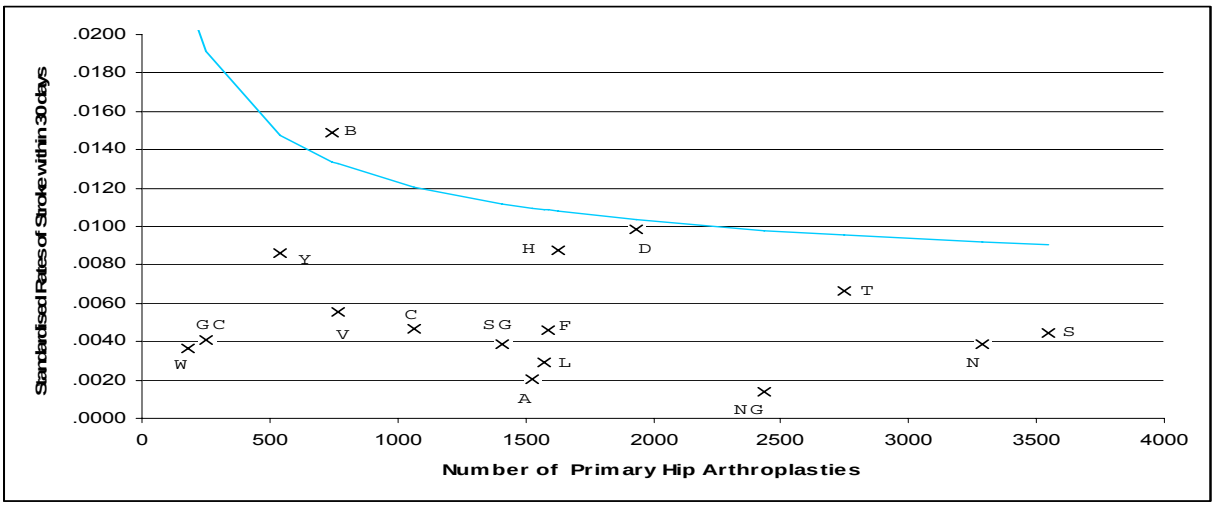


Figure 48: Standardised Rate for stroke within 30 days of a primary knee replacement

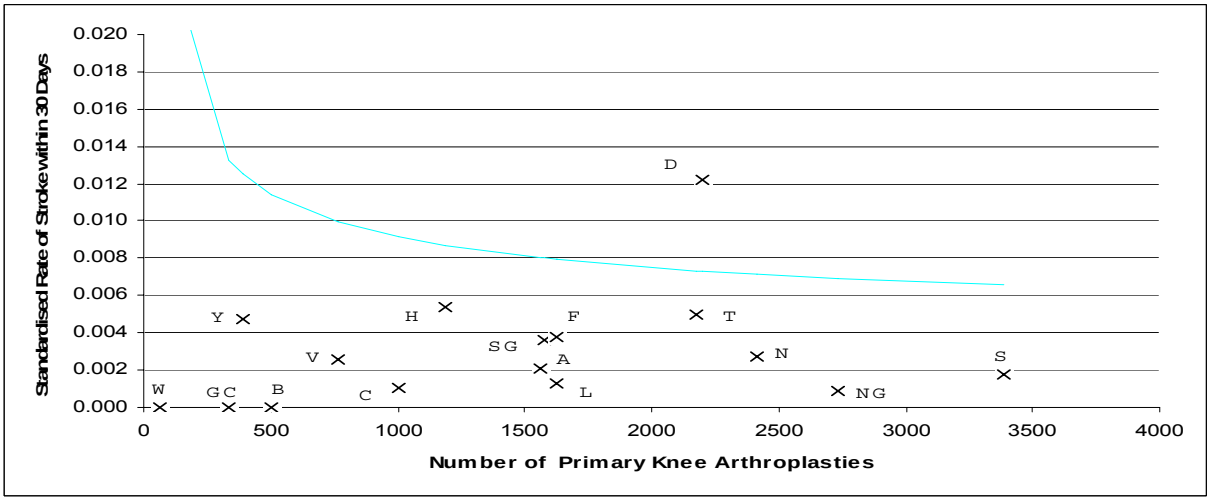


Figure 49: Standardised Rate for renal failure within 30 days of a primary hip replacement

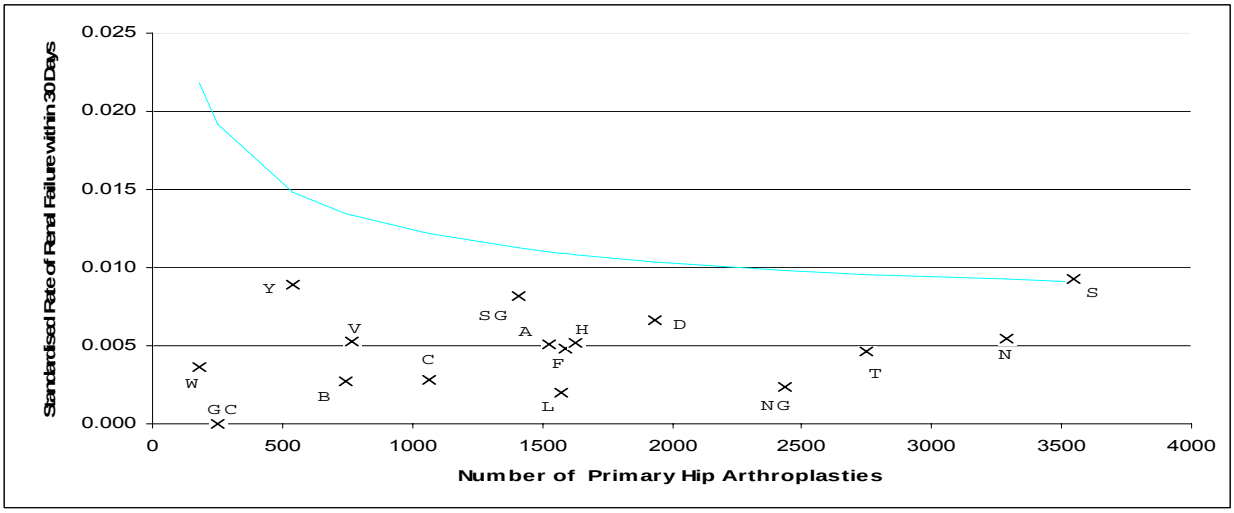


Figure 50: Standardised Rate for renal failure within 30 days of a primary knee replacement

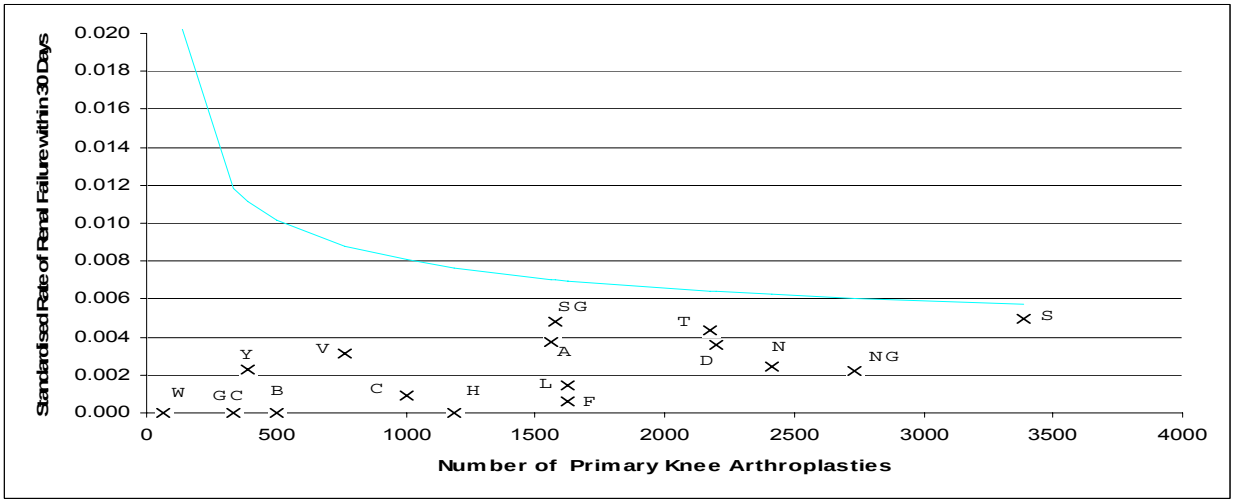


Figure 51: Standardised Rate for AMI within 30 days of a hip revision

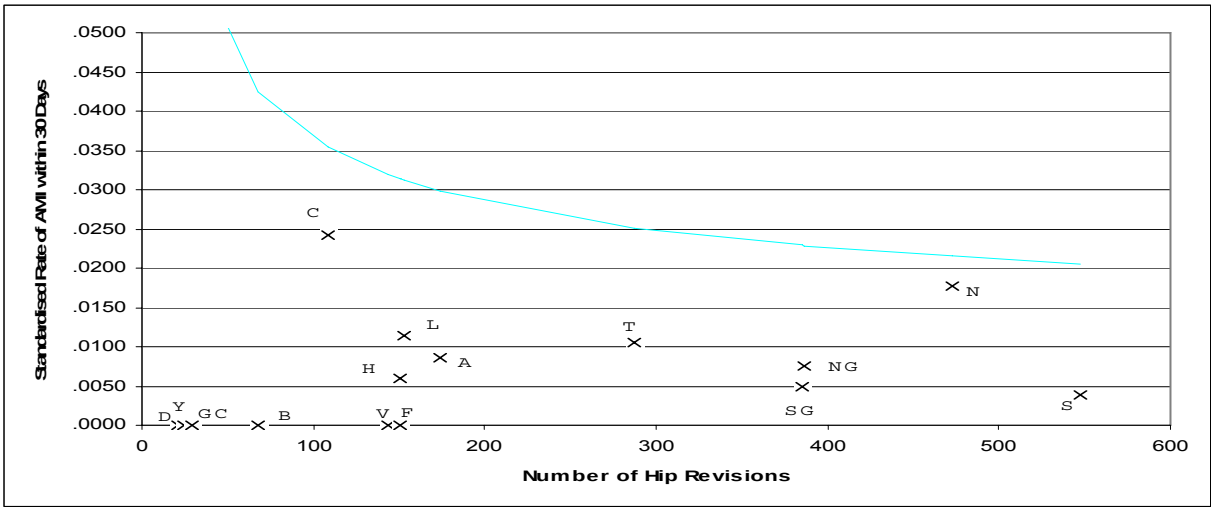


Figure 52: Standardised Rate for AMI within 30 days of a knee revision

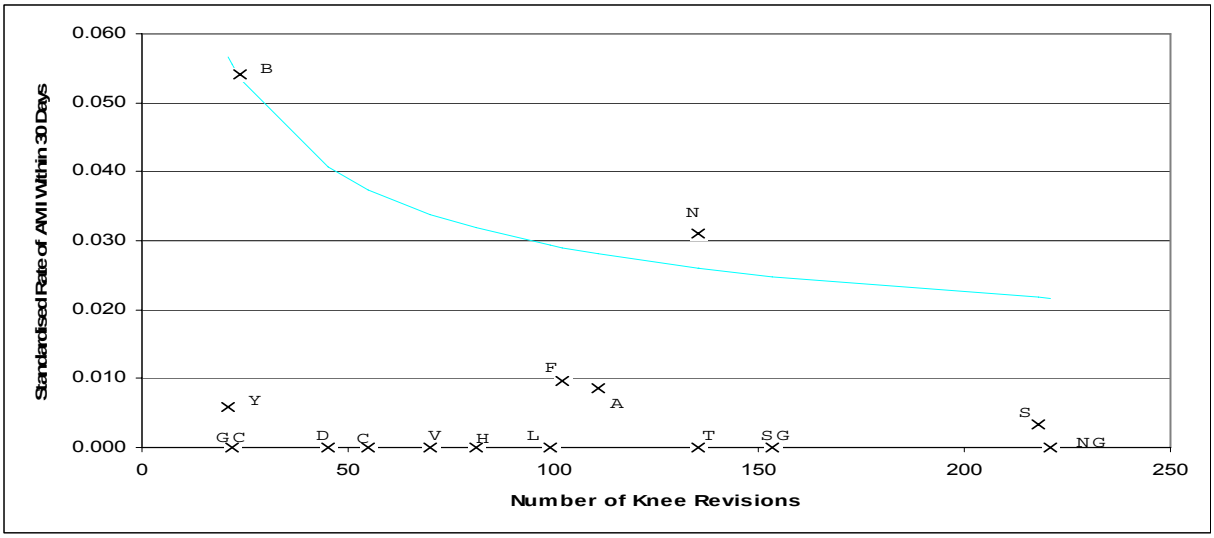


Figure 53: Standardised Rate for stroke within 30 days of a hip revision

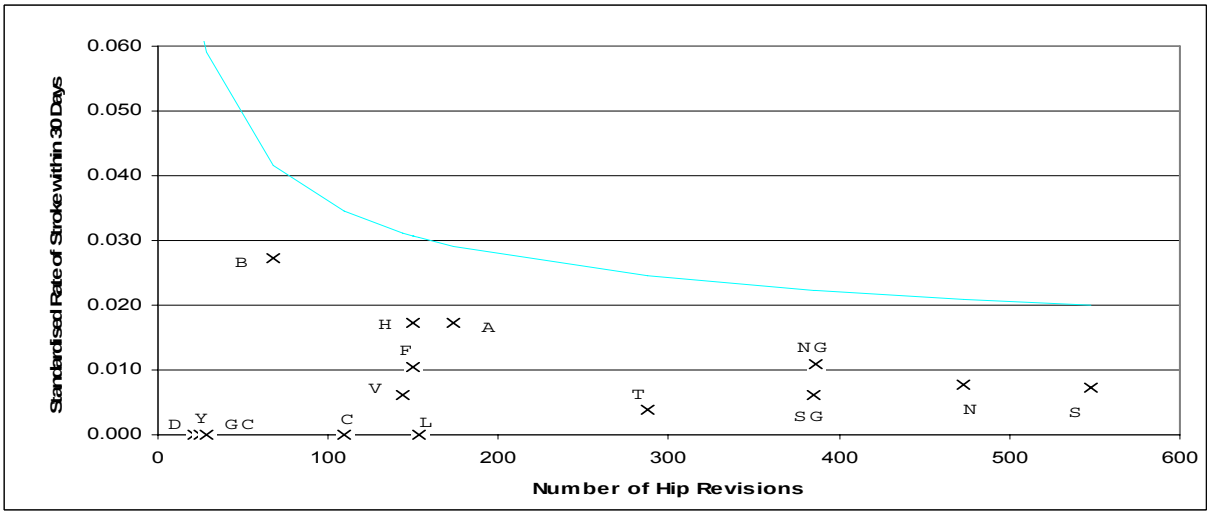


Figure 54: Standardised Rate for stroke within 30 days of a knee revision

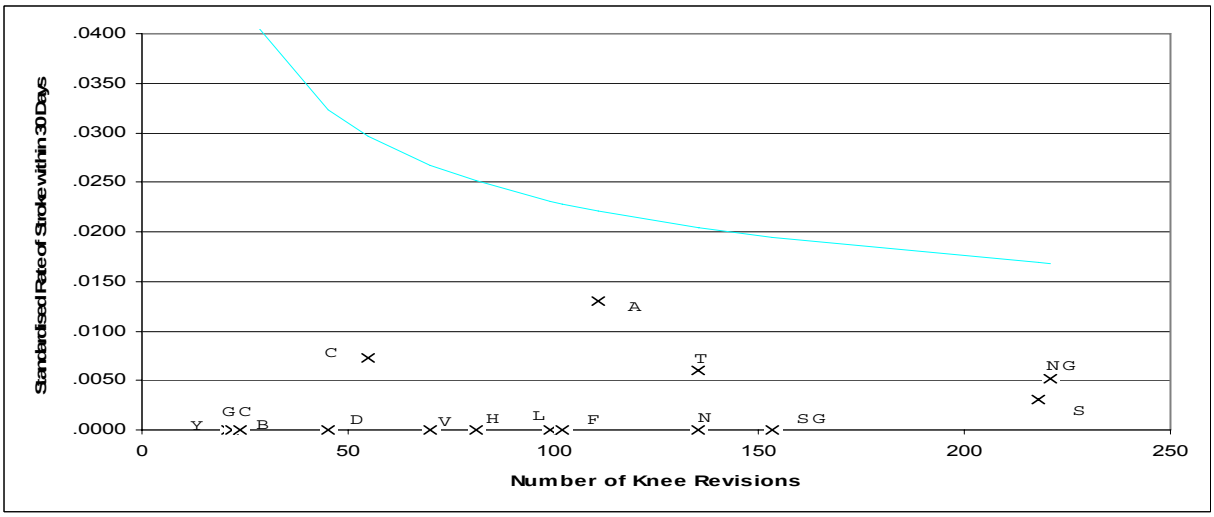


Figure 55: Standardised Rate for renal failure within 30 days of a hip revision

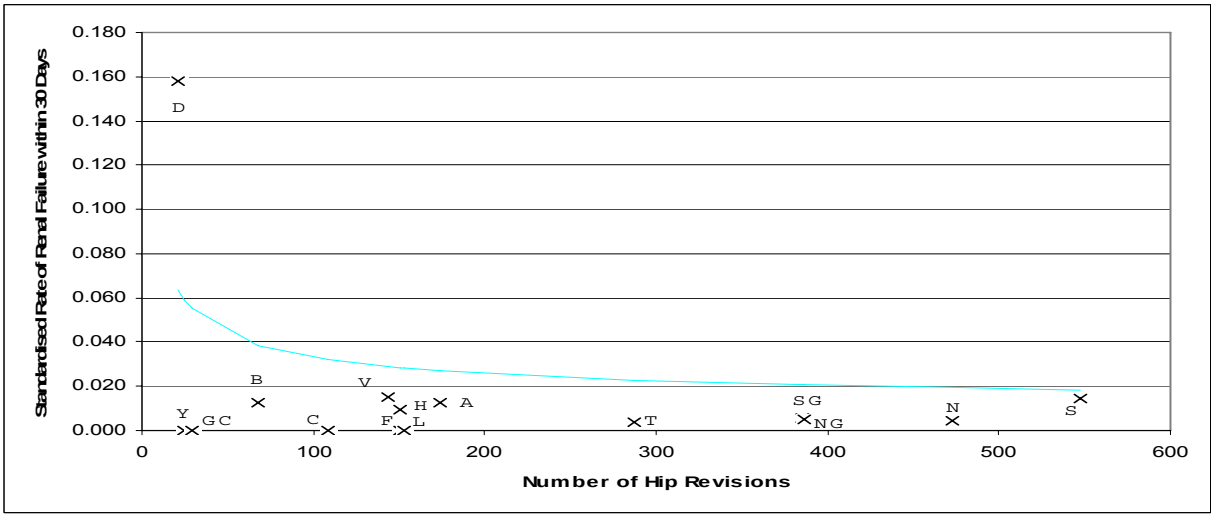
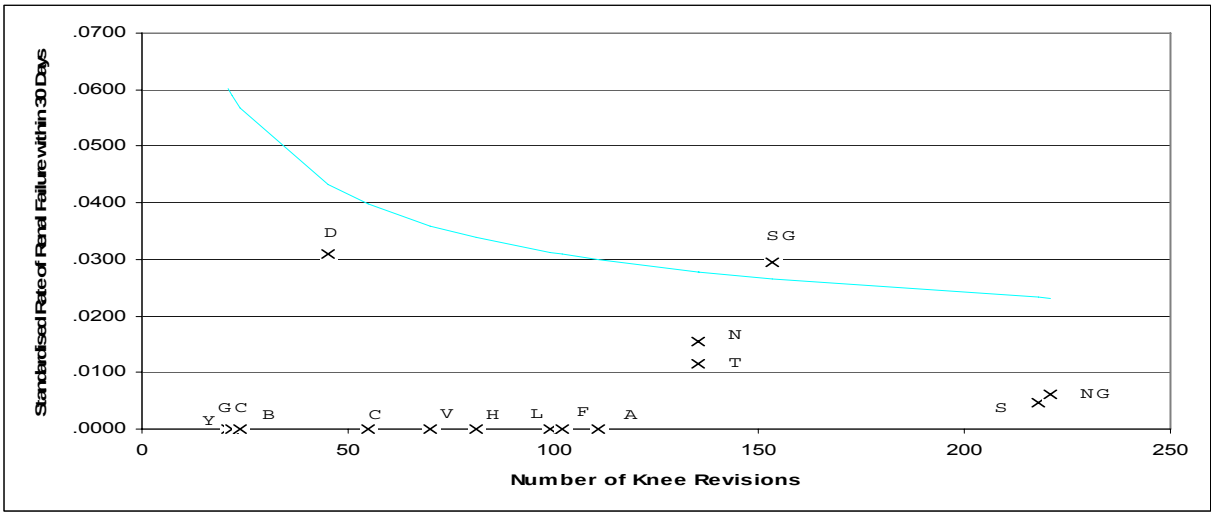


Figure 56: Standardised Rate for renal failure within 30 days of a knee revision



12. Cross Border Flow of Hip and Knee Arthroplasty and Revision Surgery within Scotland

NHS Health services within Scotland are delivered to the population through 14 Health Board of Treatments. There is also a National Waiting Times Centre Board (Golden Jubilee National Hospital) which is a hospital used to assist in reducing waiting times in Scotland. There are times when patients cannot receive an operation in their local health facility. Due to the geography of the country, many patients who live in the Scottish Islands (Shetland and Orkney) have to travel to the mainland for their operation, as dedicated specialties are not provided in their own NHS Board. Patients are also sent to the Golden Jubilee National Hospital if the waiting list in the local area is too long.

It was of interest to the Committee of the Scottish Arthroplasty Project to look at the cross border flows of patients who undergo hip and knee arthroplasty or revision. Table 18 to Table 21 show the number of local residents who have either: received treatment in their own NHS Board; have been exported to a different NHS Board for treatment and patients who have been imported to that NHS Board for their operation.

1.17. Cross Border Flow of Hip Arthroplasty Surgery

Table 18 shows the flow of hip arthroplasty operations across Scotland between 1997/98 to 2007/08. There were 54,361 operations carried out during these years, of which 9,054 were imported to a different NHS Board to where the patient lived. For instance, in NHS Borders, there were 1,604 operations on local residents. Out of this number, 1,351 operations were carried out in the local hospitals with 253 operations being exported to a different NHS Board. NHS Borders also carried out 406 operations on non NHS Borders residents. This is an import percentage of 23.1% and an export percentage of 15.8%. At the Golden Jubilee National Hospital, all patients are exported from all across Scotland for their hip replacement since this is a Waiting Times unit.

Table 18: Flow of hip arthroplasty operations across Scotland between 1997/98 to 2007/08

NHS Board	Number of operations on residents who had a hip replacement	Number of operations carried out on local residents	Number of operations imported to NHS Board	% of operations imported to NHS Board	Number of operations carried out in NHS Board	Number of operations exported to a different NHS Board	% of operations exported from NHS Board
NHS Ayrshire and Arran	3686	3226	204	5.9%	3430	460	12.5%
NHS Argyll and Clyde	849	596	1822	75.4%	2418	253	29.8%
NHS Borders	1604	1351	406	23.1%	1757	253	15.8%
NHS Dumfries and Galloway	1774	1269	8	0.6%	1277	505	28.5%
NHS Fife	4164	3426	19	0.6%	3445	738	17.7%
NHS Forth Valley	2553	1918	79	4.0%	1997	635	24.9%
NHS Greater Glasgow and Clyde	10119	7565	1617	17.6%	9182	2554	25.2%
Golden Jubilee	0	0	2571	100%	2571	0	0.0%
NHS Grampian	6546	6321	694	9.9%	7015	225	3.4%
NHS Highland	3490	3181	112	3.4%	3293	309	8.9%
NHS Lanarkshire	4949	3591	88	2.4%	3679	1358	27.4%
NHS Lothian	7747	7175	552	7.1%	7727	572	7.4%
NHS Orkney	382	0	0	0%	0	382	100%
NHS Shetland	332	0	0	0%	0	332	100%
NHS Tayside	5339	5258	869	14.2%	6127	81	1.5%
NHS Western Isles	572	439	4	0.9%	443	133	23.3%
Totals		45316	9045		54361		

1.18. Cross Border Flow of Hip Revision Surgery

Table 19 shows the flow of hip revisions across Scotland between 1997/98 to 2007/08. There were 8,776 revisions carried out during these years of which 1,612 operations were imported to a different NHS Board to where the patient lived. For instance, in NHS Greater Glasgow and Clyde, there were 1,901 operations on local residents. Out of this number, 1,654 operations were carried out in local hospitals with 247 operations being exported to a different NHS Board. NHS Greater Glasgow and Clyde also carried 686 operations imported to them from other NHS Boards. This is an import percentage of 29.3% and an export percentage of 13%.

Table 19: Flow of hip revisions across Scotland between 1997/98 to 2007/08

NHS Board	Number of operations on residents who had a hip replacement	Number of operations carried out on local residents	Number of operations imported to NHS Board	% of operations imported to NHS Board	Number of operations carried out in NHS Board	Number of operations exported to a different NHS Board	% of operations exported from NHS Board
NHS Ayrshire and Arran	573	424	17	3.9%	441	149	26.0%
NHS Argyll and Clyde	168	75	243	76.4%	318	93	55.4%
NHS Borders	195	149	24	13.9%	173	46	23.6%
NHS Dumfries and Galloway	245	66	2	2.9%	68	176	73.1%
NHS Fife	640	475	4	0.8%	479	165	25.8%
NHS Forth Valley	503	397	7	1.7%	404	106	21.1%
NHS Greater Glasgow and Clyde	1901	1654	686	29.3%	2340	247	13.0%
Golden Jubilee	0	0	40	100%	40	0	0%
NHS Grampian	1136	1096	143	11.5%	1239	40	3.5%
NHS Highland	371	323	49	13.2%	372	48	12.9%
NHS Lanarkshire	773	490	23	4.5%	513	283	36.6%
NHS Lothian	1263	1240	233	15.8%	1473	23	1.8%
NHS Orkney	73	0	0	0%	0	73	100%
NHS Shetland	51	0	0	0%	0	51	100%
NHS Tayside	796	766	141	15.5%	907	30	3.8%
NHS Western Isles	49	9	0	0%	9	40	81.6%
Totals		7164	1612		8776		

1.19. Cross Border Flow of Knee Replacement

Table 20 shows the flow of knee replacements across Scotland between 1997/98 to 2007/08. There were 45,513 replacements carried out during these years with 7,783 operations being imported to a different NHS Board to where the patient lives. For instance, in NHS Dumfries and Galloway, there were 1,175 operations on local residents. Out of this number, 808 operations were carried out in local hospitals with 367 operations being exported to different NHS Boards. This NHS Board only had three operations imported to them from other NHS Boards. This is an import percentage of 0.4% and an export percentage of 31.2%.

Table 20: Flow of knee arthroplasty operations across Scotland between 1997/98 to 2007/08

NHS Board	Number of operations on residents who had a knee replacement	Number of operations carried out on local residents	Number of operations imported to NHS Board	% of operations imported to NHS Board	Number of operations carried out in NHS Board	Number of operations exported to a different NHS Board	% of operations exported from NHS Board
NHS Ayrshire and Arran	3388	3035	145	4.6%	3180	353	10.4%
NHS Argyll and Clyde	576	368	1392	79.1%	1760	208	36.1%
NHS Borders	956	758	185	19.6%	943	198	20.7%
NHS Dumfries and Galloway	1175	808	3	0.4%	811	367	31.2%
NHS Fife	3724	3263	30	0.9%	3293	461	12.4%
NHS Forth Valley	2507	1814	69	3.7%	1883	693	27.6%
NHS Greater Glasgow and Clyde	10564	8048	1318	14.1%	9366	2516	23.8%
Golden Jubilee	0	0	3131	100%	3131	0	0%
NHS Grampian	4240	4077	444	9.8%	4521	163	3.8%
NHS Highland	2846	2008	83	4%	2091	838	29.4%
NHS Lanarkshire	4632	3152	99	3%	3251	1480	32%
NHS Lothian	6547	6204	371	5.6%	6575	343	5.2%
NHS Orkney	195	0	0	0%	0	195	100%
NHS Shetland	279	0	0	0%	0	279	100%
NHS Tayside	4113	4052	512	11.2%	4564	61	1.5%
NHS Western Isles	219	143	1	0.7%	144	76	34.7%
Totals		37730	7783		45513		

1.20. Cross Border Flow of Knee Revision Surgery

Table 21 shows the flow of knee revisions across Scotland between 1997/98 to 2007/08. There were 3,231 revisions carried out during these years, of which 549 operations being imported to a different NHS Board to where the patient lives. For instance, in NHS Lothian, there were 392 operations on local residents. Out of this number, 385 operations were carried out in local hospitals with seven operations being exported to different NHS Boards. NHS Lothian had 78 operations imported to them from other NHS Boards. This is an import percentage of 16.8% and a small export percentage of 1.8%.

Table 21: Flow of knee revisions across Scotland between 1997/98 to 2007/08

NHS Board	Number of operations on residents who had a hip replacement	Number of operations carried out on local residents	Number of operations imported to NHS Board	% of operations imported to NHS Board	Number of operations carried out in NHS Board	Number of operations exported to a different NHS Board	% of operations exported from NHS Board
NHS Ayrshire and Arran	285	250	7	2.7%	257	35	12.3%
NHS Argyll and Clyde	43	17	92	84.4%	109	26	60.5%
NHS Borders	56	44	10	18.5%	54	12	21.4%
NHS Dumfries and Galloway	91	50	1	2%	51	41	45.1%
NHS Fife	270	212	0	0%	212	58	21.5%
NHS Forth Valley	182	138	8	5.5%	146	44	24.2%
NHS Greater Glasgow and Clyde	847	724	183	20.2%	907	123	14.5%
Golden Jubilee	0	0	82	100%	82	0	0%
NHS Grampian	238	230	22	8.7%	252	8	3.4%
NHS Highland	192	123	12	8.9%	135	69	35.9%
NHS Lanarkshire	294	188	11	5.5%	199	106	36.1%
NHS Lothian	392	385	78	16.8%	463	7	1.8%
NHS Orkney	8	0	0	0%	0	8	100%
NHS Shetland	12	0	0	0%	0	12	100%
NHS Tayside	327	320	43	11.8%	363	7	2.1%
NHS Western Isles	20	1	0	0%	1	19	95%
Totals		2682	549		3231		

13. Kaplan-Meier Survival of Hip and Knee Replacements

It is possible to use the routine SMR01 data to graphically illustrate the survival of both hip and knee joint replacements. The type of survival analysis used in this section is known as Kaplan-Meier survival analysis. The graphs are constructed by selecting a particular group of patients, following them over a set period of time and monitoring if and when they have their joint revised. At day zero, no patients have had their joint revised and hence the survival is always one. When a patient has a joint revised, the survival rate drops. In this case, a higher survival rate is better. For the analyses, we used the Log-rank test to investigate survival rates of the groups of patients (Bland et al 2004).

1.21. Hip Arthroplasty

Table 22 shows the number of primary hip replacements carried out between April 1998 and March 2008 split between age, volume of procedure and type of arthritis. The Log-rank tests indicate that age group and arthritis type show significant differences in the time to revision. For example, patients aged over 75 will on average find that there is a longer time before they need their joint revised than a patient aged less than 55 years (see

Figure 57).

Table 22: Revision of Primary Hip replacements for operations performed between April 1998 – March 2008

Grouping	Total Primary hip Replacements	Surviving to end point/dying before end point	Log-rank Statistic	p-value
Age of patient			31.349	<0.001
<55 years	4,893	4,702		
55 – 75 years	26,125	25,383		
>75 years	12,547	12,295		
Volume of procedures performed by surgeons			1.5040	0.220
0-20 hips per year	14,002	13,654		
21+ hips per year	29,563	28,726		
Diagnosis			9.2880	<0.005
Osteoarthritis	36,609	35,684		
Rheumatoid arthritis	956	913		

Figure 57: Revision after Primary Hip Replacement; April 1998 - March 2008

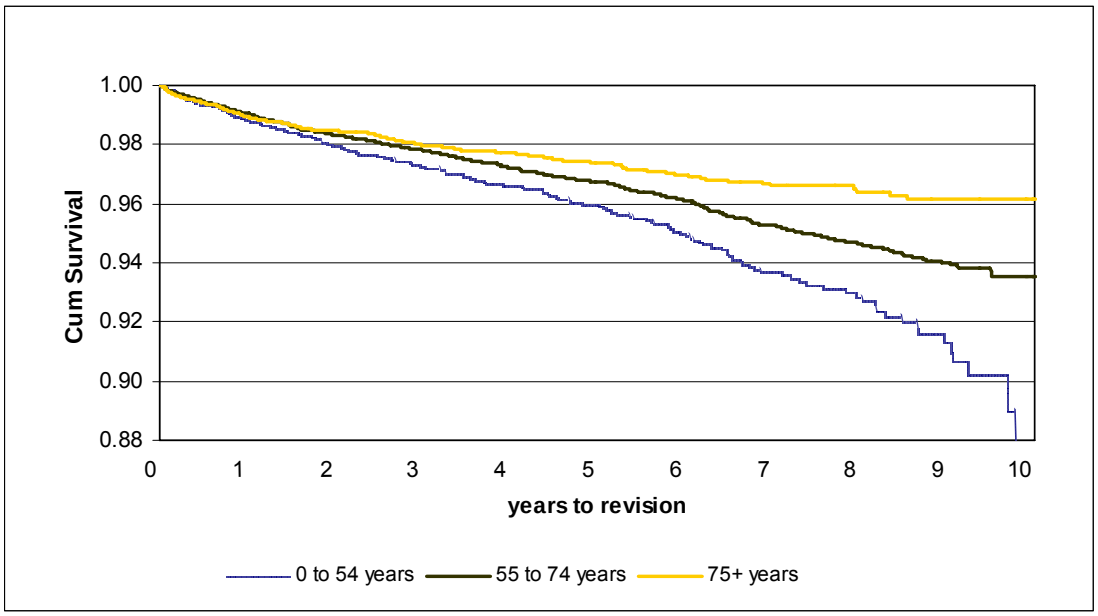


Figure 58: Revision after Primary Hip Replacement; April 1998 - March 2008

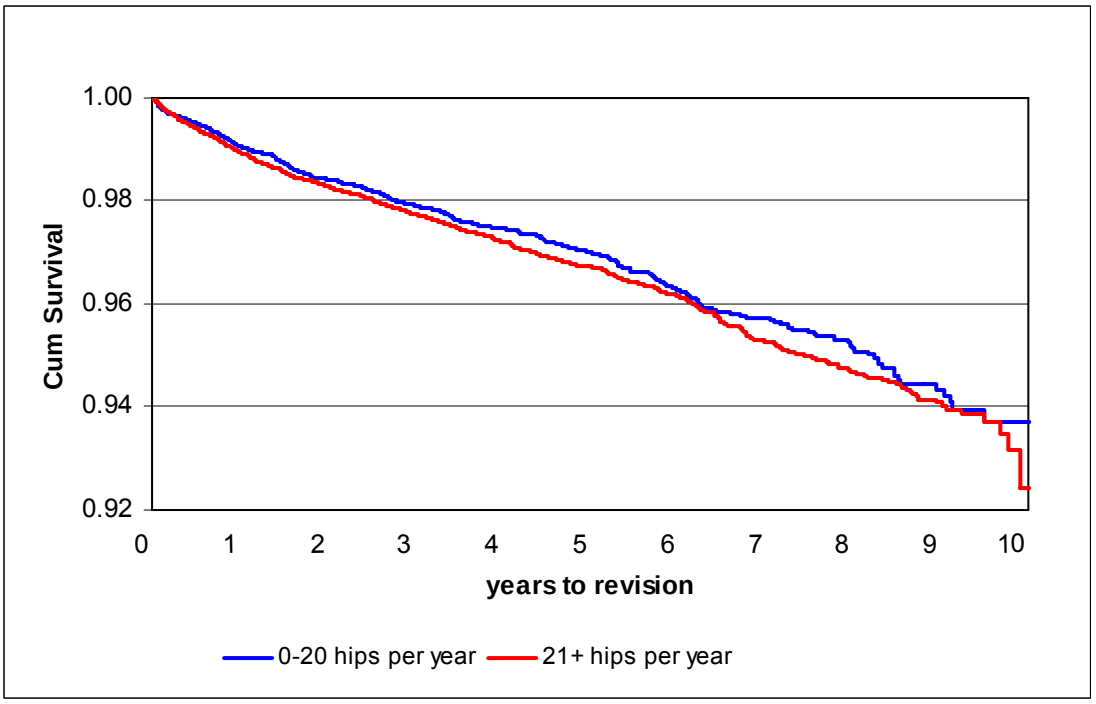
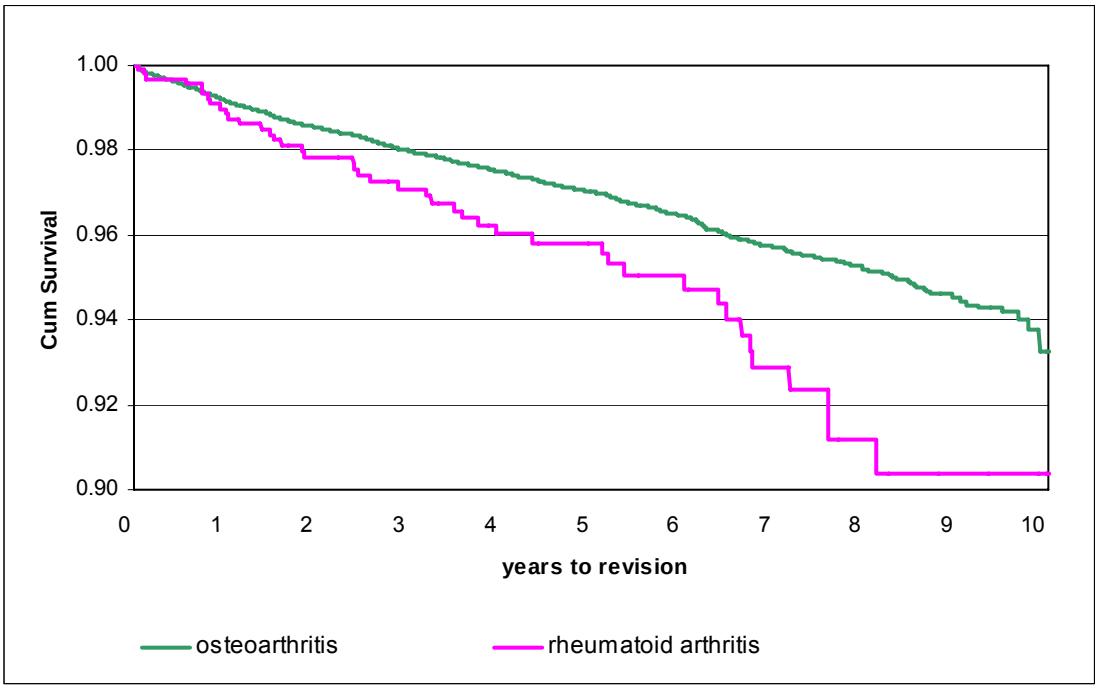


Figure 59: Revision after Primary Hip Replacement; April 1998 - March 2008



1.22. Knee Arthroplasty

Table 22 shows the number of primary knee replacements carried out between April 1998 and March 2008 split between age, volume of procedure and type of arthritis. The Log-rank tests indicate that age group shows significant differences in the time to revision. Patients aged over 75 will on average find that there is a longer time before they need their joint revised than a patient aged less than 55 years (see Figure 60).

Table 23: Revision of Primary Knee replacements for operations performed between April 1998 – March 2008

Grouping	Total Primary knee Replacements	Surviving to end point/dying before end point	Log-rank Statistic	p-value
Age of patient			82.586	<0.001
<55 years	2,001	1,899		
55 – 75 years	22,175	21,481		
>75 years	10,840	10,655		
Volume of procedures performed by surgeons			1.352	0.245
0-20 knees per year	6,154	6,017		
21+ knees per year	28,862	28,018		
Diagnosis			0.272	0.602
Osteoarthritis	31,772	30,896		
Rheumatoid arthritis	1,449	1,406		

Figure 60: Revision after Primary Knee Replacement; April 1998 - March 2008

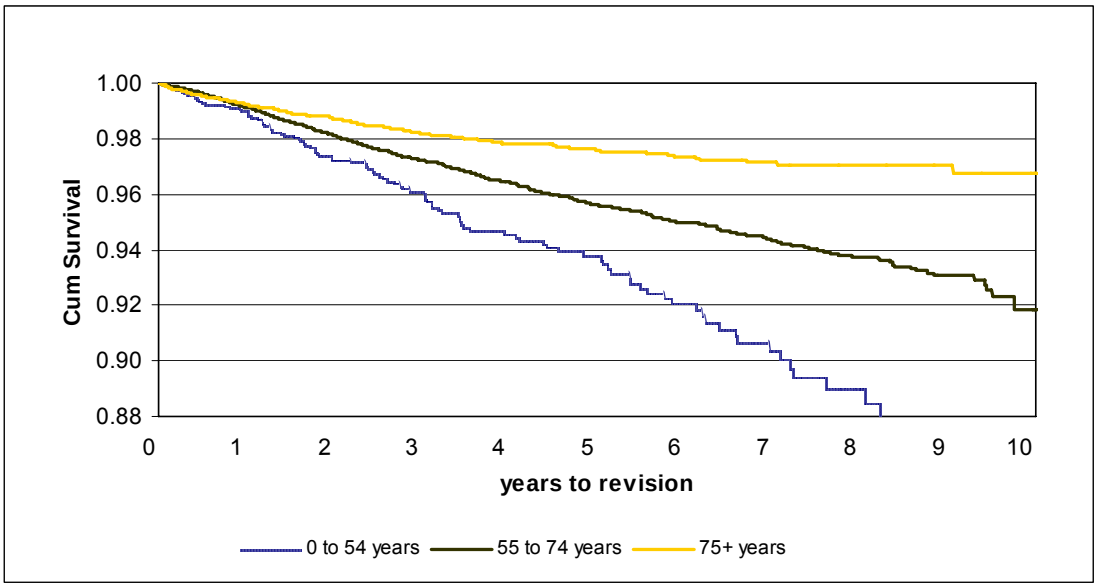


Figure 61: Revision after Primary Knee Replacement; April 1998 - March 2008

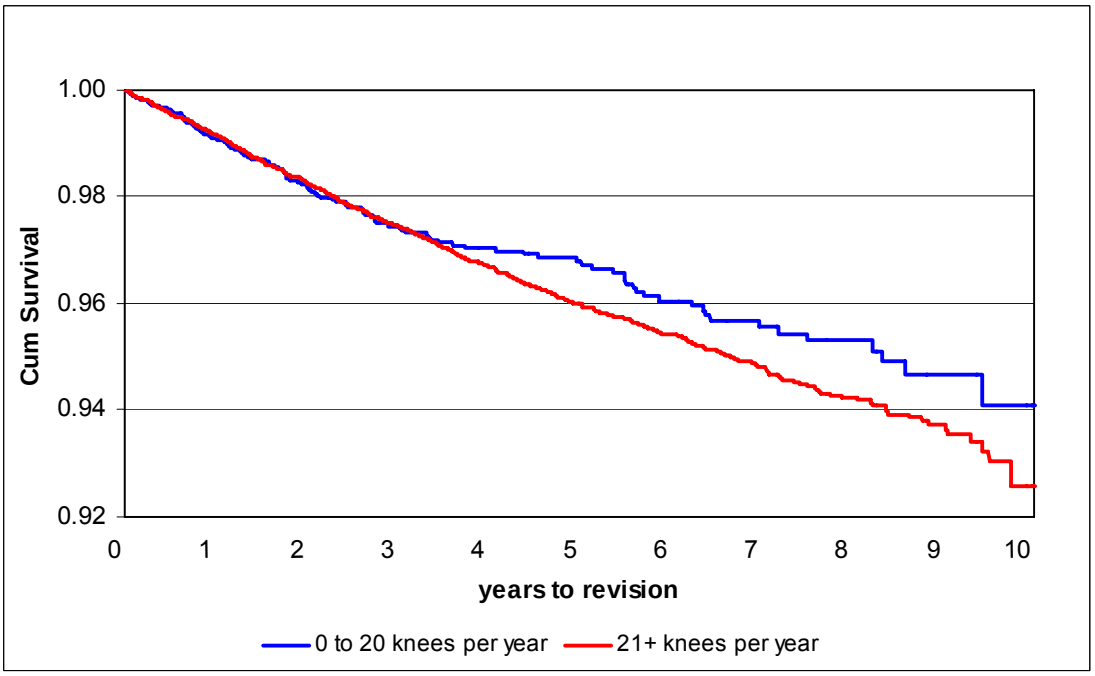
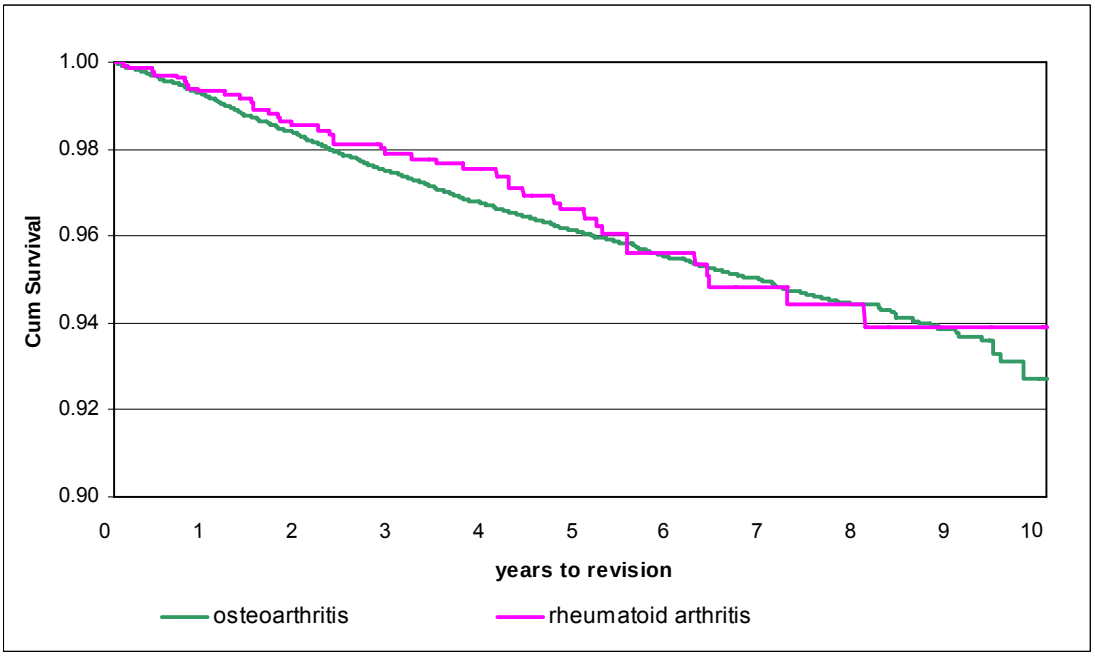


Figure 62: Revision after Primary Knee Replacement; April 1998 - March 2008



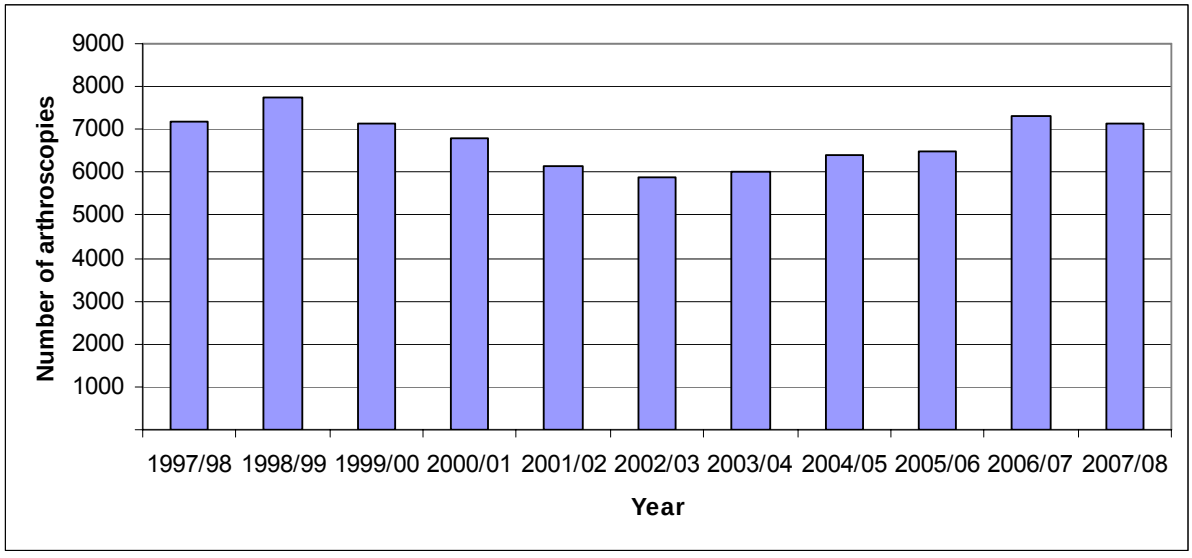
14. Knee Arthroscopies

Investigating the general trends in the number of Arthroscopies was first explored in the 2007 Annual Report. This area of interest is again examined this year. An arthroscopy can be performed on most joints. This analysis, however, focuses on the arthroscopy of the knee.

Data from financial years 1997/98 to 2007/08 has been extracted from the SMR01 records. The data has been broken down by: Inpatient/Daycases and age group by Health Board of Residence. In addition, there is also analysis on the number of patients aged 60 years and over who underwent a total and hemi knee replacement within two years of having an arthroscopy.

Figure 63 shows the number of arthroscopies in Scotland from financial year 1997/98 to 2007/08. There was a decrease in the number of arthroscopies from 7725 in 1998/1999 to 5865 in 2002/03. However, the number of arthroscopies has increased since then to 7303 in 2006/07 with a small decrease in 2007/08 to 7142.

Figure 63: The number of arthroscopies conducted in Scotland from 1997/98 to 2007/08



As with a number of common and less complex surgical procedures, it is becoming more common for an arthroscopy to be done as a daycase. Figure 64 and Figure 65 below shows the split between the numbers of patients who were treated as a daycase or inpatient from 1997/1998 to 2007/08.

Figure 64: The number of daycases and inpatients from 1997/1998 to 2007/2008

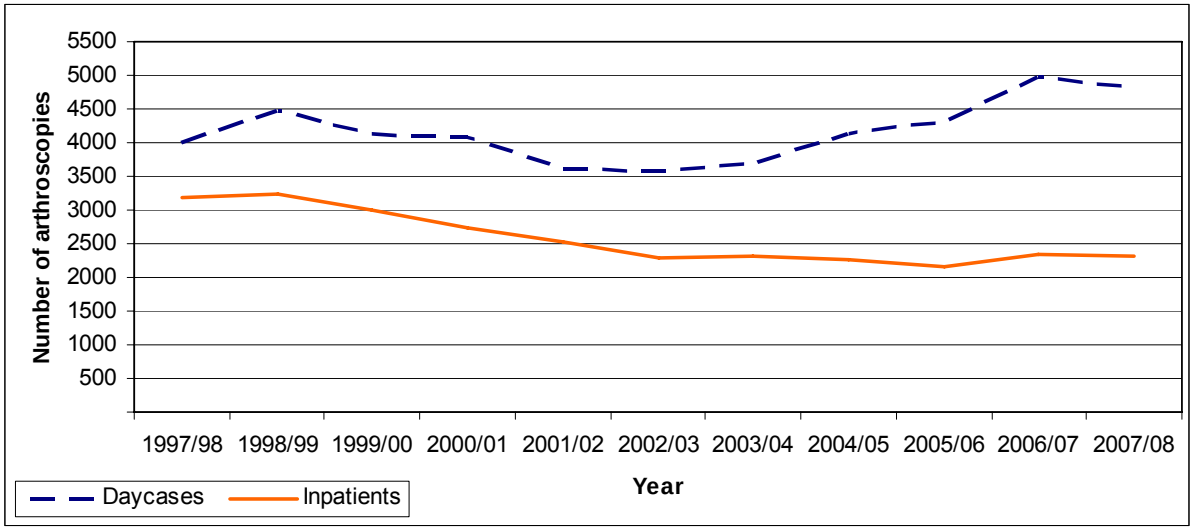


Figure 65: The percentage change of daycases and inpatients from 1997/98 to 2007/08

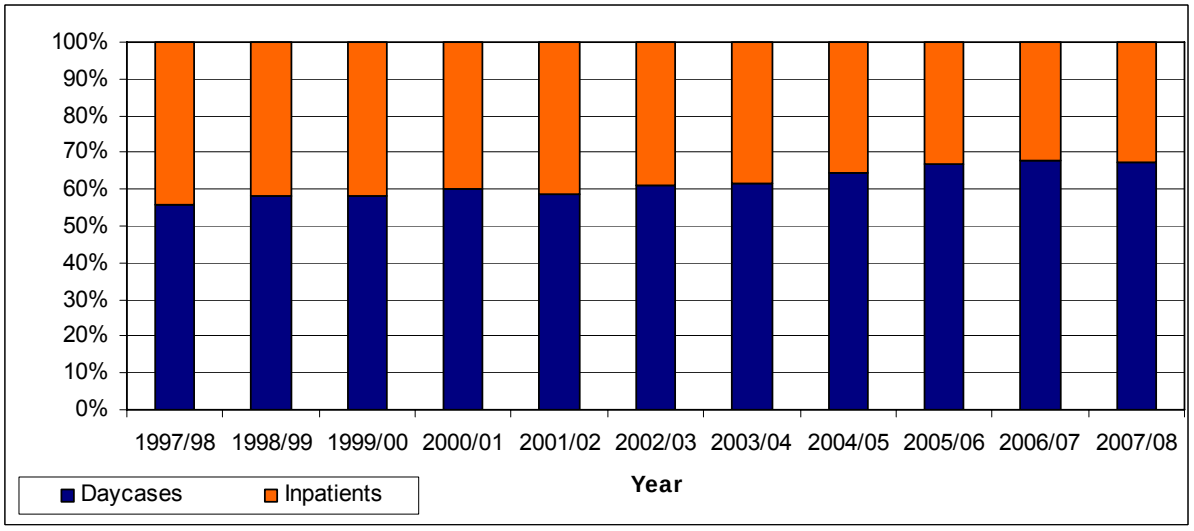


Figure 66 to Figure 80 show the rates of arthroscopies at a Scotland level, per 100,000 and each Health Board of Residence. The rates of arthroscopy are shown in 10-year age groups from 1997/98 to 2007/08, and are based on the actual NHS Board population in each age group.

Figure 66: Age Group Rate of Arthroscopies for Scotland

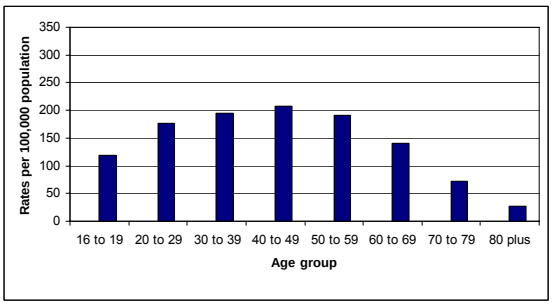


Figure 67: Age Group Rate of Arthroscopies for Ayrshire and Arran

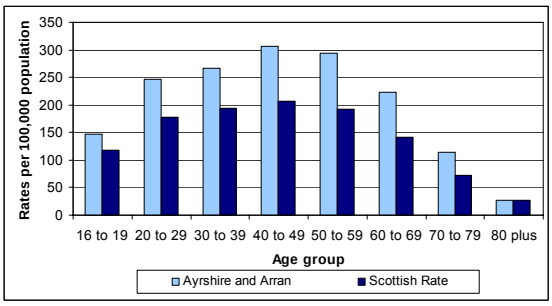


Figure 68: Age Group Rate of Arthroscopies for Borders

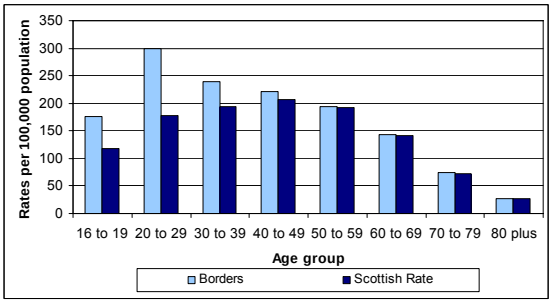


Figure 69: Age Group Rate of Arthroscopies for Dumfries and Galloway

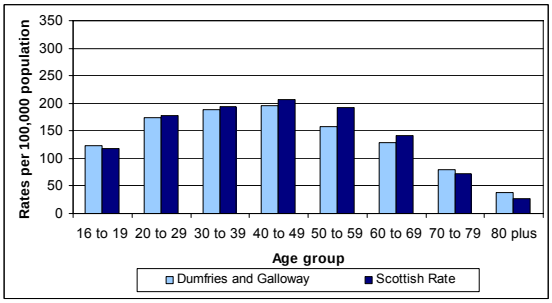


Figure 70: Age Group Rate of Arthroscopies for Fife

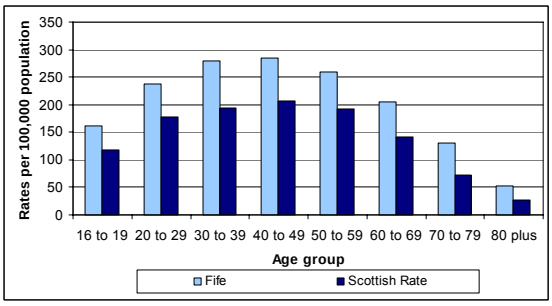


Figure 71: Age Group Rate of Arthroscopies for Forth Valley

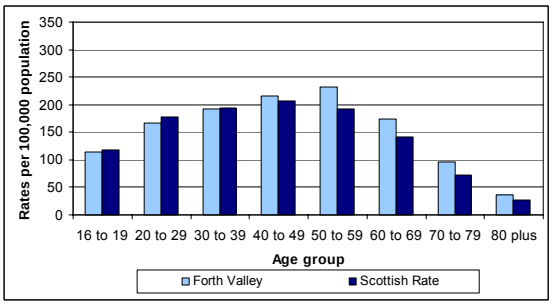


Figure 72: Age Group Rate of Arthroscopies for Greater Glasgow & Clyde

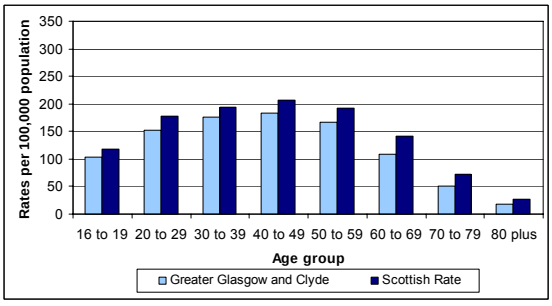


Figure 73: Age Group Rate of Arthroscopies for Grampian

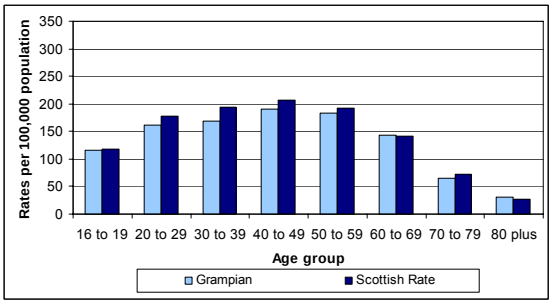


Figure 74: Age Group Rate of Arthroscopies for Highland

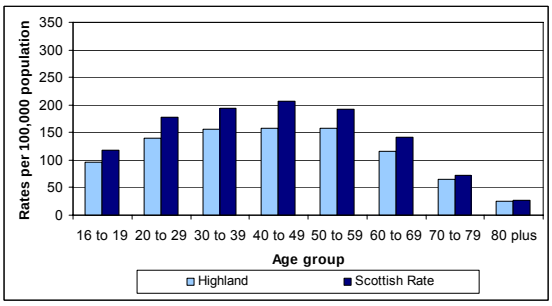


Figure 75: Age Group Rate of Arthroscopies for Lanarkshire

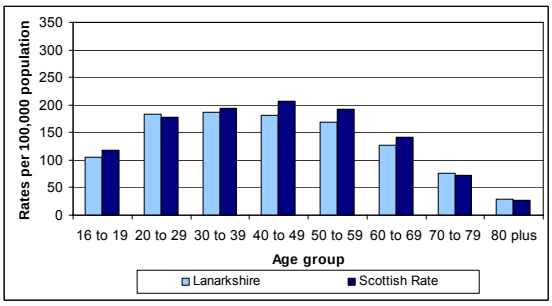


Figure 76: Age Group Rate of Arthroscopies for Lothian

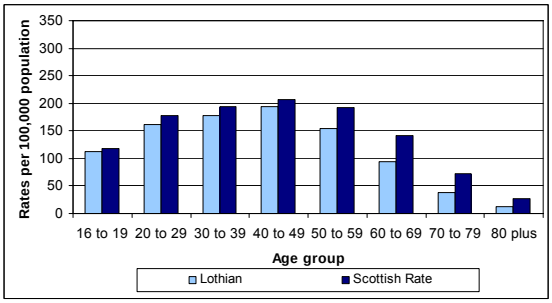


Figure 77: Age Group Rate of Arthroscopies for Orkney

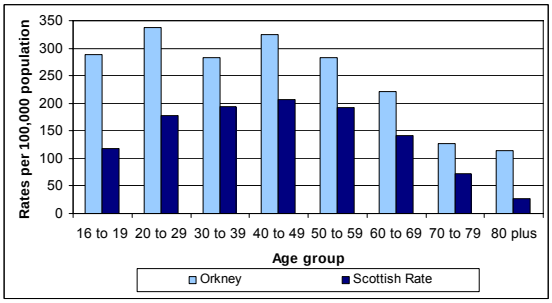


Figure 78: Age Group Rate of Arthroscopies for Shetland

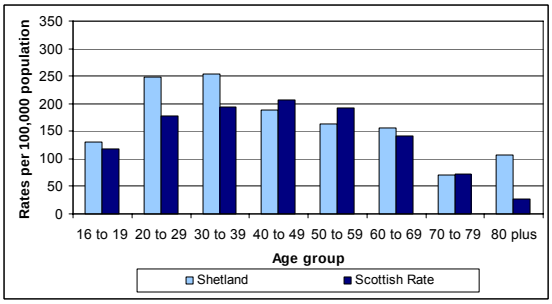


Figure 79: Age Group Rate of Arthroscopies for Tayside

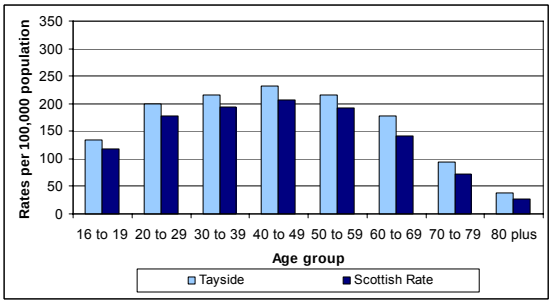
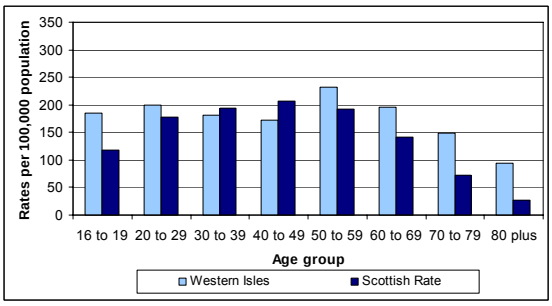
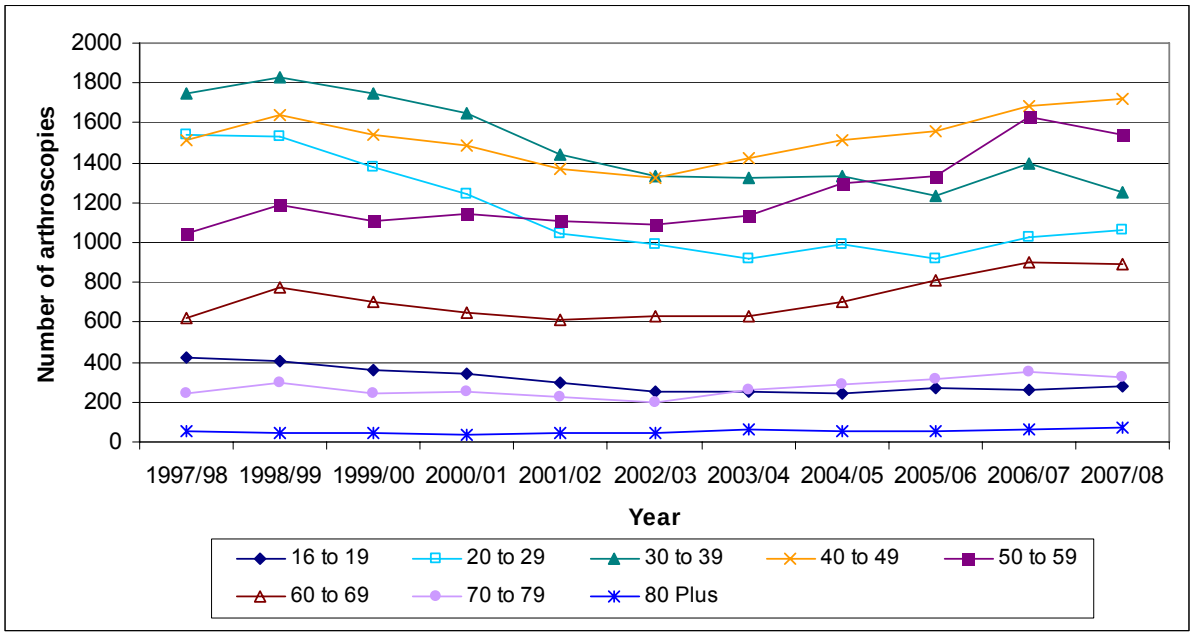


Figure 80: Age Group Rate of Arthroscopies for Western Isles



The average age of a patient undergoing a knee arthroscopy in the 11-year period is 43 years, which is the same age as the nine-year period in the 2007 Annual Report. Figure 81 shows how the number of arthroscopies for each 10 year age range has changed from 1997/98 to 2007/08.

Figure 81: Change over time in number of arthroscopies for each 10 year age range



A further area of interest to the committee was the number of patients over 60 years of age who went on to have a total or hemi knee replacement within two years of having an arthroscopy. Figure 82 shows the Scotland rate and Health Board of Residence rate (per 100,000 of each Health Board of Residence population) where the patient has undergone a total or hemi knee replacement within two years of having an arthroscopy (for arthroscopies performed between 1st April 1997 and 31st March 2006). Figure 83 shows the actual number of arthroscopies corresponding to the rates in Figure 82.

Figure 82: Rates per 100,000 of population aged 60+ for each NHS Board of residence where patients have undergone a primary total or hemi knee replacement within 2 years of an arthroscopy.

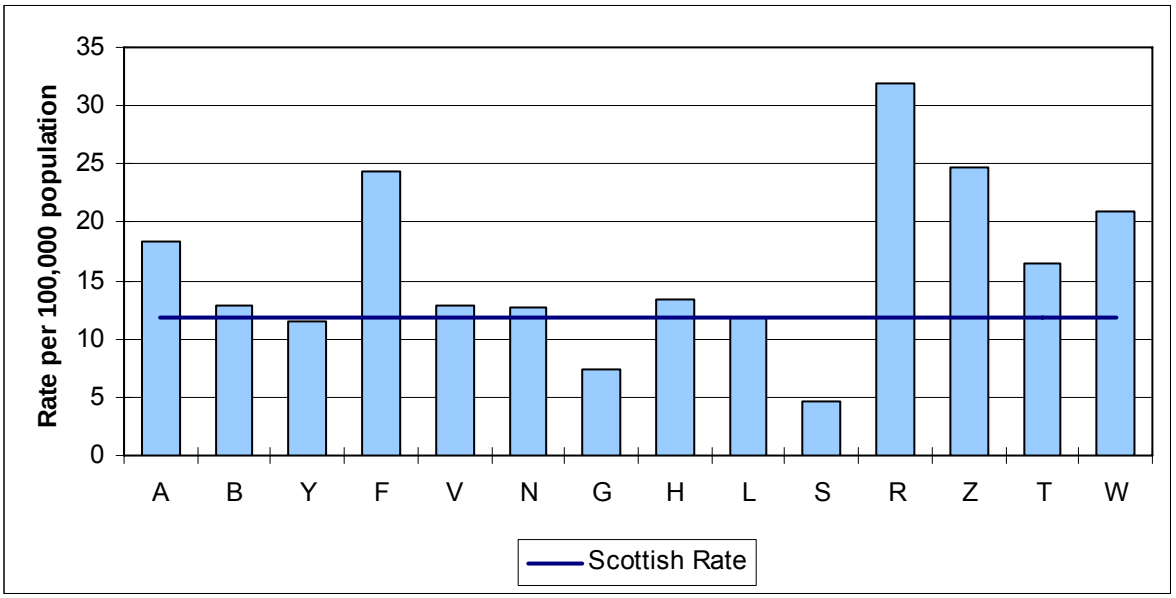
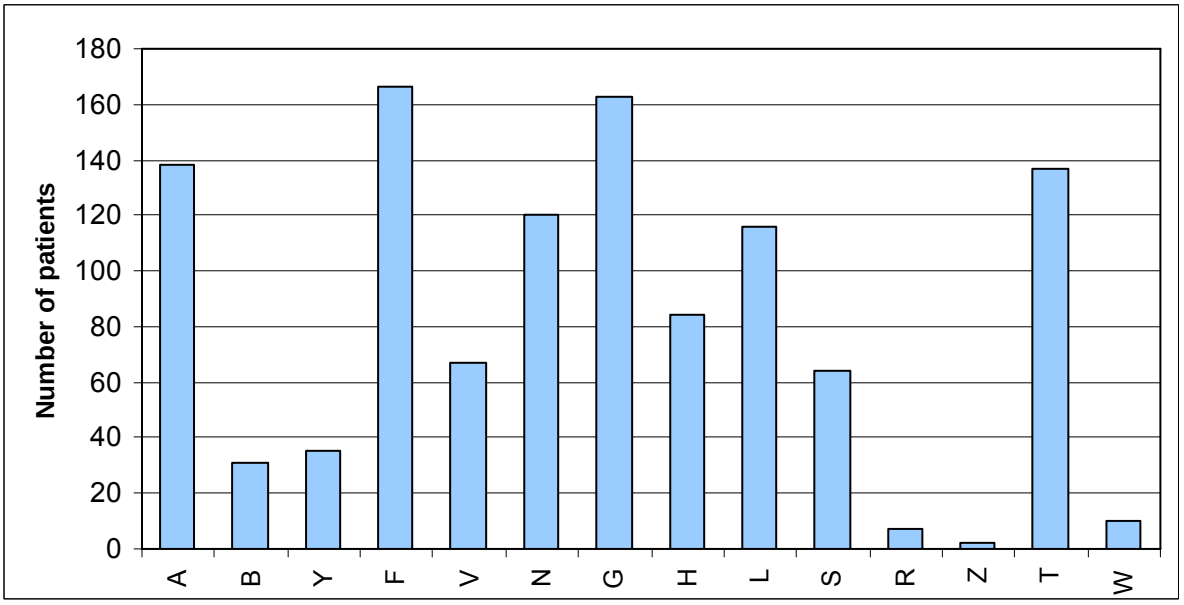


Figure 83: Number of patients aged 60+ having a total or hemi knee replacement within 2 years of a knee arthroscopy by NHS Board of Residence.



Key to NHS Board of Residence Ciphers

A:	Ayrshire and Arran	H:	Highland
B:	Borders	L:	Lanarkshire
Y:	**Dumfries and Galloway**	S:	Lothian
F:	Fife	R:	Orkney
V:	**Forth Valley**	Z:	Shetland
N:	Grampian	T:	Tayside
G:	Greater Glasgow and Clyde	**W:**	**Western Isles**

15. Appendix

1.23. Consent

Consent issues for patients and participants have been discussed and opinion has been widely canvassed. The SMR01 dataset is firmly embedded in the administrative structure of NHSScotland and is used for audit and demographic description. It is important that patients are informed of the use of their data in this kind of project. NHS Boards are already providing generic information to patients explaining how their data are used by NHS Scotland and their rights with respect to this. As part of the process of improving the information available to patients a poster to inform them about the Scottish Arthroplasty Project has been prepared and is being displayed in Orthopaedic departments across Scotland (The poster is available to download from www.arthro.scot.nhs.uk).

1.24. Confidentiality

To date, no identifiable patient data linkable to individual consultant surgeons has been produced or reviewed outside ISD. Only the consultant surgeon concerned has been asked to review these data in order to respect data protection principles (that apply equally to the patient and consultant surgeon). Other than one member of the ISD staff (and then only for administrative purposes), no-one in the project has access to individually identifiable data and therefore cannot comment on or release information on individuals. While this should reassure participants, it also places considerable responsibilities on consultant surgeons to respond to the data supplied. It must be pointed out that the relatively small size of the consultant Orthopaedic community in Scotland may occasionally make absolute anonymity difficult.

This confidentiality brings with it responsibility. The Arthroplasty Project under the aegis of the Orthopaedic community (SCOT) has developed a process of review to ensure that any results which appear to vary from normal are interpreted at a local level to apply appropriate knowledge and ensure local action. All outlying results are followed up and local review requested.

The advent of the Freedom of Information (Scotland) Act 2002 has led us to consider the confidentiality of our processes. A debate has taken place about the desirability or otherwise of publishing individual-level surgeons' audit results. While publication of named data seems

superficially attractive, and has happened in other branches of surgery, it has neither informed the debate nor the individual patient. We provide all surgeons with their own results which can be used to inform the consent process. To date we have been successful in providing information which is useful and would inform the decision making process when a patient is considering joint replacement. Individual surgeons results will require local interpretation at the time of interview between patient and surgeon.

Consent is the process of two parties agreeing together. The risks and benefits of surgery are unique to the health, lifestyle and expectations of the patient taken together with the knowledge and experience of the surgeon. We have informed the surgeon of their overall results to use in this process. It would be appropriate if patients ask for these figures during the consent process.

1.25. Committee Structure

The Project is overseen by the Scottish Committee for Orthopaedics and Trauma (SCOT), who elect a chair for the Project. The Project is then managed by the Scottish Arthroplasty Steering Committee, whose membership is as follows;

- Mr Ivan Brenkel, Orthopaedic Consultant, Chair
- Mr Colin Howie, Orthopaedic Consultant
- Mr Andrew Kinninmonth, Orthopaedic Consultant
- Mr Paddy Ashcroft, Oththopedic Consultant
- Dr David Semple, Anaesthetic Consultant (Appointed by the Royal College of Anaesthetists Board in Scotland)
- Mrs Jennifer Boyd, ISD project co-ordinator
- Mr Roger Black, Head of Quality Improvement Programme
- Dr Margaret MacLeod, Quality Improvement Programme Manager
- Dr Penny Bridger, ISD Consultant in Public Health
- Ms Miriam Watts, Independent Hospitals representative
- Ms Hazel Bruce and Ms Katy Green, patient representatives; and representative of the Scottish Association of Medical Directors acting in advisory capacity where necessary.

The Orthopaedic Consultants sitting on the Steering Committee, including the Committee chair, are nominated by the SCOT Committee and the organisational representative is nominated by the Scottish Association of Trust Medical Directors. The term of office for all nominees is 3 years, with an option to renew this term once. This does not apply to committee members who are not nominated, i.e. ISD staff. Other health professionals (e.g.

nurses, physiotherapists) will be invited to join the steering committee as outcome indicators develop for areas of care to which these professions directly contribute.

The function of the Steering Committee is to plan the medium and long-term strategy of the Project under the direction of SCOT. The Committee also directs the clinical content of the annual report and of any other data analyses produced and manages the clinical governance aspect of the Project.

1.26. Staffing

The project is managed on a day-to-day basis by staff at the Information Services Division, which is a division of the NSS. Approximately 1.5 whole-time equivalent ISD staff are dedicated to SAP. The clinical lead and chair of the project is a consultant Orthopaedic surgeon and three further consultant Orthopaedic surgeons and an anaesthetic consultant sit on the Steering Committee, which meets three times per year. A member of the public and a representative from the independent hospitals sector also contribute by sitting on the Steering Committee.

1.27. Action Plan

Scottish Arthroplasty Project:

Action Plan resulting from the identification of data outwith normal variation

GMC 9999999

Name: A N Other

Outlier Indicator: dislocations within 365 days following hip arthroplasty

Number of hip arthroplasties that you performed: 40

Number of expected dislocations for 40 cases: 1 +/- 2.33

Action Plan following review of cases (please continue on separate sheet if necessary).

Signed:

Co-signed: **GMC Number of Co-signatory**:

Print Name:

(This signatory must be a GMC registered doctor with whom you have discussed this information and who will confirm what actions have been taken. This colleague may be your medical manager, medical director or a senior colleague and need not be employed within your Trust.)

1.28. References

AOA National Joint Replacement Registry Annual Report

Bland JM, Altman DG. The logrank test. BMJ.;328(7447):1073, 2004

Delivering for Health, Scottish Executive, Edinburgh 2005

Harley M. Mohammed MA. Hussain S. Yates J. Almasri A. Was Rodney Ledward a statistical outlier? Retrospective analysis using routine hospital data to identify gynaecologists' performance BMJ.;330(7497):929, 2005

Norwegian Arthroplasty Register Annual Report 2007

American Academy of Orthopaedic Surgeons

Swedish National Hip Arthroplasty Register Annual Report 2007

Swedish Knee Arthroplasty Register Annual Report 2008

National Joint Register For England and Wales, 5th Annual Report

Canadian Joint Replacement Registery (CJRR) Annual Report 2007

1.29. Previous Scottish Arthroplasty Project Annual Reports

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2008

http://www.arthro.scot.nhs.uk/Reports/Scottish_Arthroplasty_Project_Report_2008.pdf

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2007

http://www.arthro.scot.nhs.uk/Reports/Scottish_Arthroplasty_Project_Report_2007.pdf

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2006

http://www.arthro.scot.nhs.uk/Reports/Arthro_Report_2006.pdf

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2005

http://www.arthro.scot.nhs.uk/Reports/Scottish_Arthroplasty_Final_Report_2005_Web.pdf

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2004

http://www.show.scot.nhs.uk/arthro/Reports/Scottish_Arthroplasty_Project_Report_2004.pdf

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2003

http://www.show.scot.nhs.uk/arthro/Reports/Scottish_Arthroplasty_Report_2003.pdf

Scottish Arthroplasty Project. Scottish Arthroplasty Project Annual Report 2002

http://www.show.scot.nhs.uk/arthro/Reports/Scottish_Arthroplasty_Report_2002.pdf

1.30. Other Websites

Scottish Audit of Surgical Mortality

http://www.sasm.org.uk

Statistical Process Control

http://www.isdscotland.org/isd/1123.html